US009408762B1

(12) **United States Patent**
Baker

(10) **Patent No.: US 9,408,762 B1**
(45) **Date of Patent: Aug. 9, 2016**

(54) **DRIVE SYSTEM FOR A WHEELCHAIR**

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(72) Inventor: **Scott Bradley Baker**, Sherman Oaks, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/286,804**

(22) Filed: **May 23, 2014**

Related U.S. Application Data

(63) Continuation-in-part of application No. 14/261,343, filed on Apr. 24, 2014, now abandoned, which is a continuation of application No. 14/151,631, filed on Jan. 9, 2014, now abandoned, which is a continuation of application No. 14/029,138, filed on Sep. 17, 2013, now abandoned, which is a continuation-in-part of application No. 13/134,888, filed on Jun. 20, 2011, now Pat. No. 8,540,266, which is a continuation-in-part of application No. 12/315,548, filed on Dec. 4, 2008, now Pat. No. 7,963,539.

(60) Provisional application No. 61/005,439, filed on Dec. 5, 2007, provisional application No. 61/005,446, filed on Dec. 5, 2007, provisional application No. 61/005,447, filed on Dec. 5, 2007.

(51) **Int. Cl.**

A61G 5/02	(2006.01)
A61G 5/08	(2006.01)

(52) **U.S. Cl.**
CPC ***A61G 5/023*** (2013.01); ***A61G 5/025*** (2013.01); ***A61G 5/08*** (2013.01); *A61G 2005/0883* (2013.01)

(58) **Field of Classification Search**
CPC A61G 5/02; A61G 5/023; A61G 5/025
See application file for complete search history.

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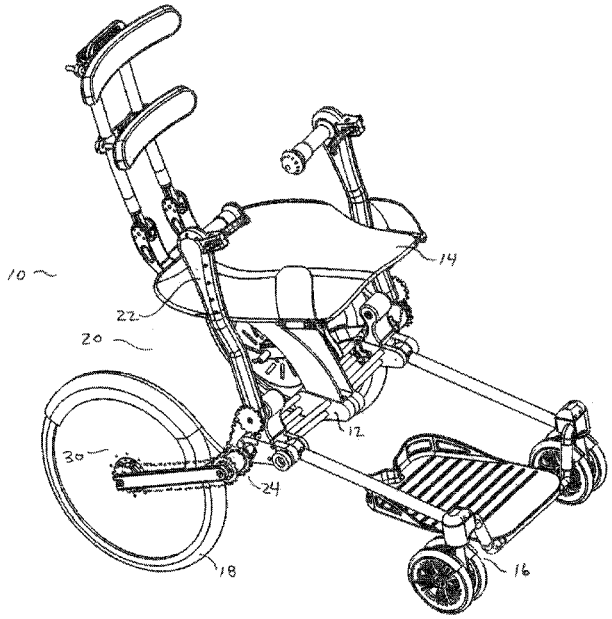
Primary Examiner — Tony Winner
(74) *Attorney, Agent, or Firm* — Coun P. Abrahams

(57) **ABSTRACT**

A wheelchair comprises a frame or chassis, a seat mounted on the chassis, a front wheel assembly mounted on the chassis, and a pair of rear wheels mounted on the chassis. A drive train assembly propels the wheelchair in a selectively forward or reverse direction. The drive train assembly comprises an arm lever which can be moved back and forth by the user, a drive member connected to the arm lever by means of a chain, and a rear wheel hub assembly connected to the drive member by means of a chain.

29 Claims, 44 Drawing Sheets



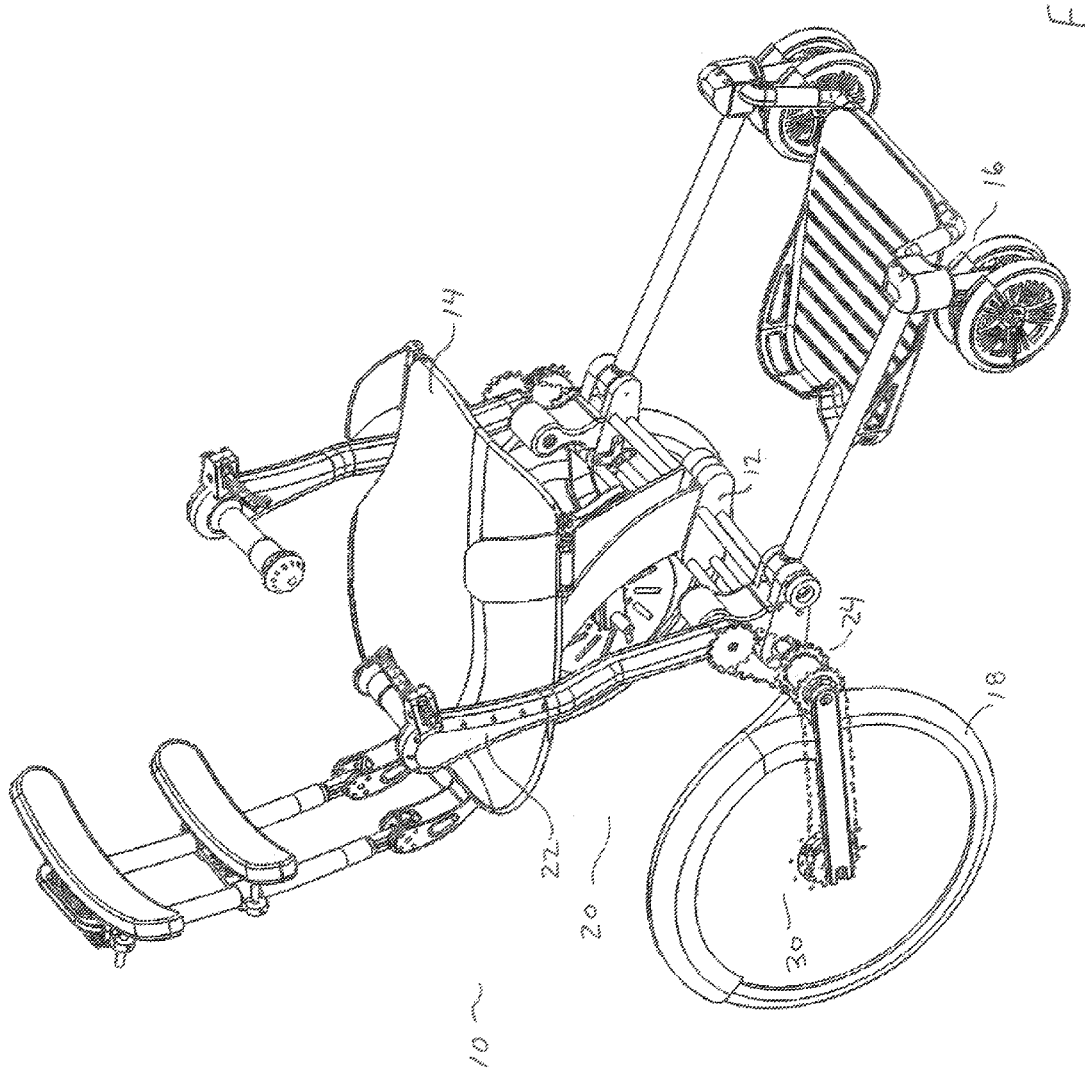


FIG. 1

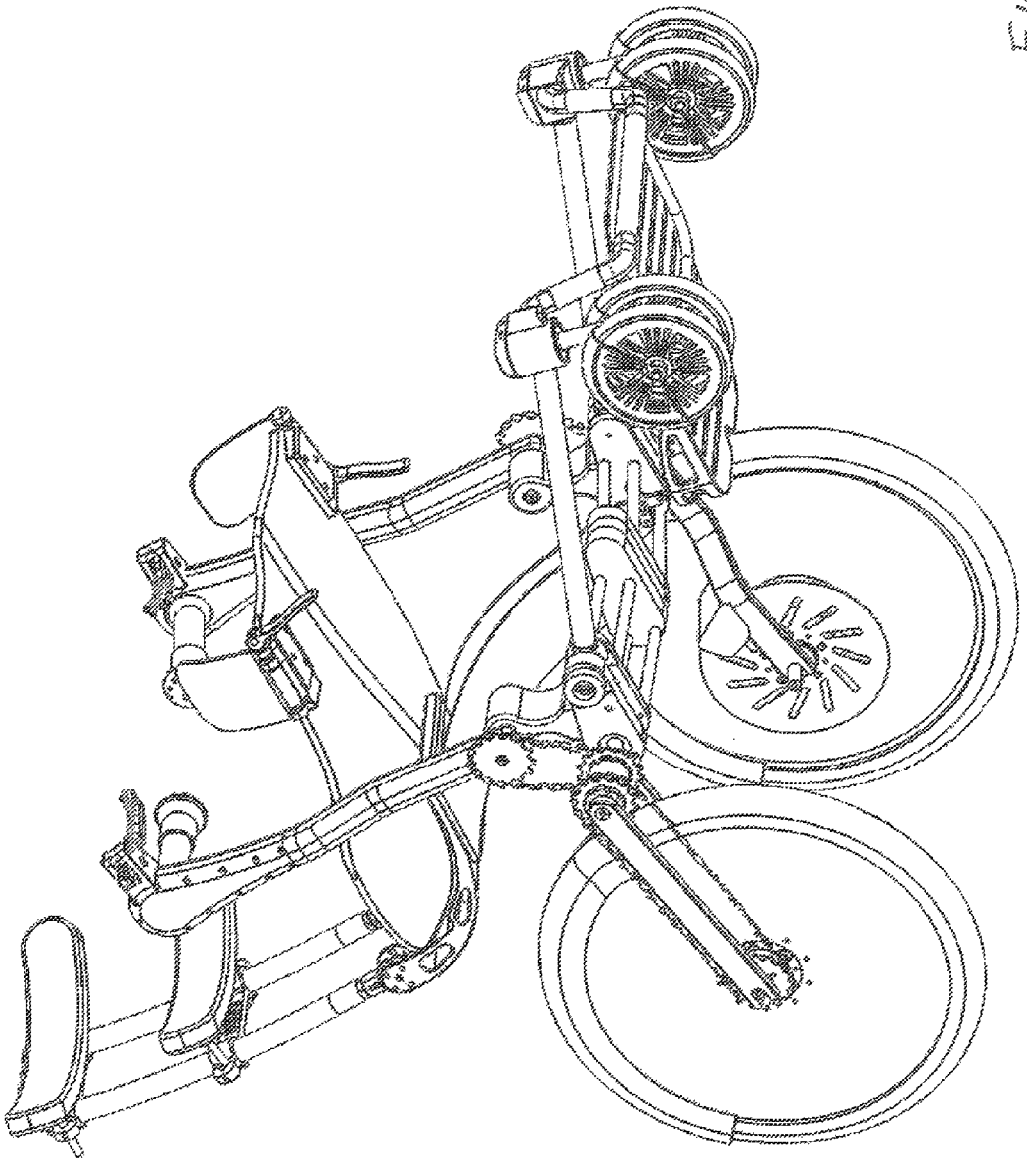


FIG. 2

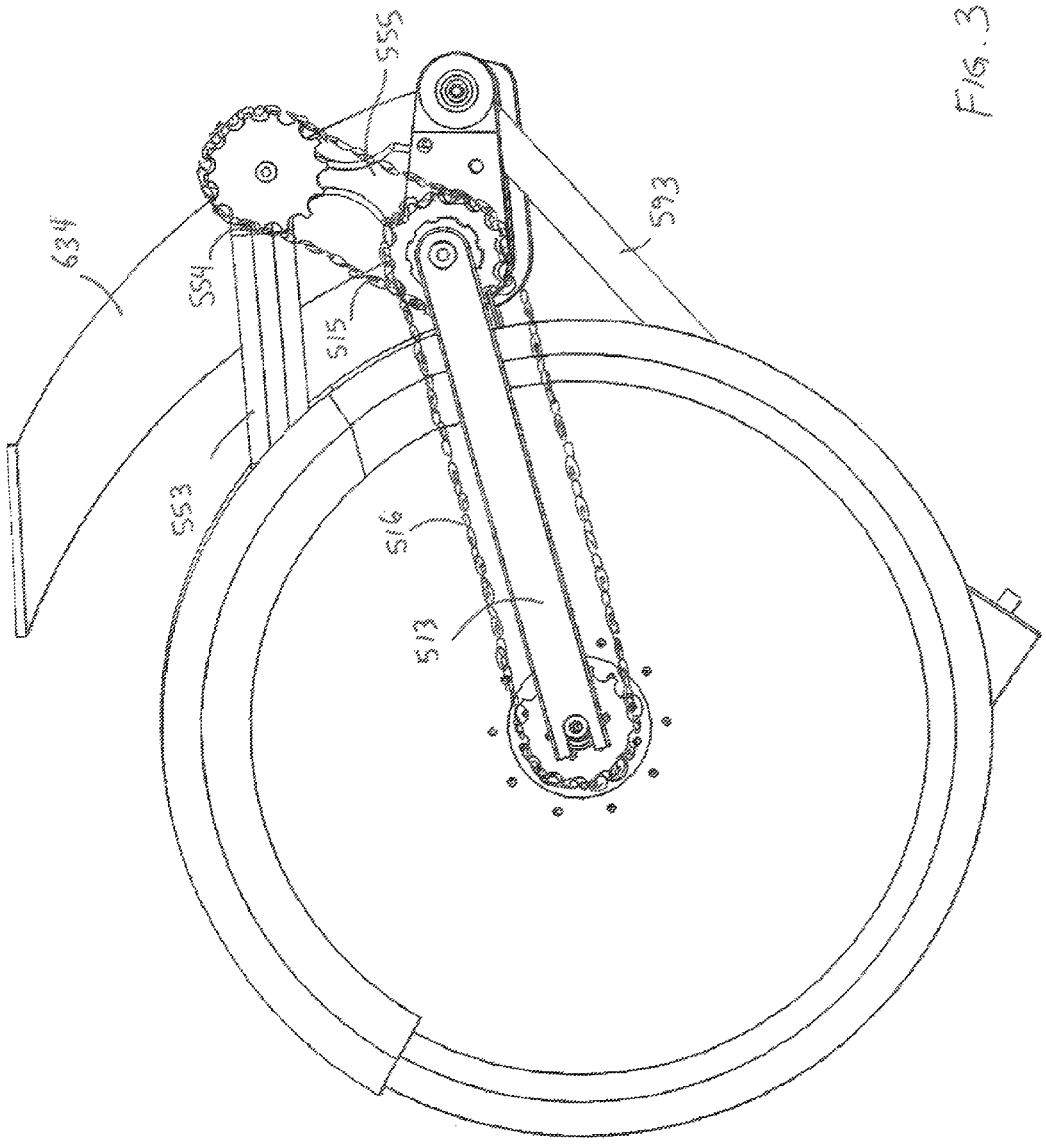


FIG. 3

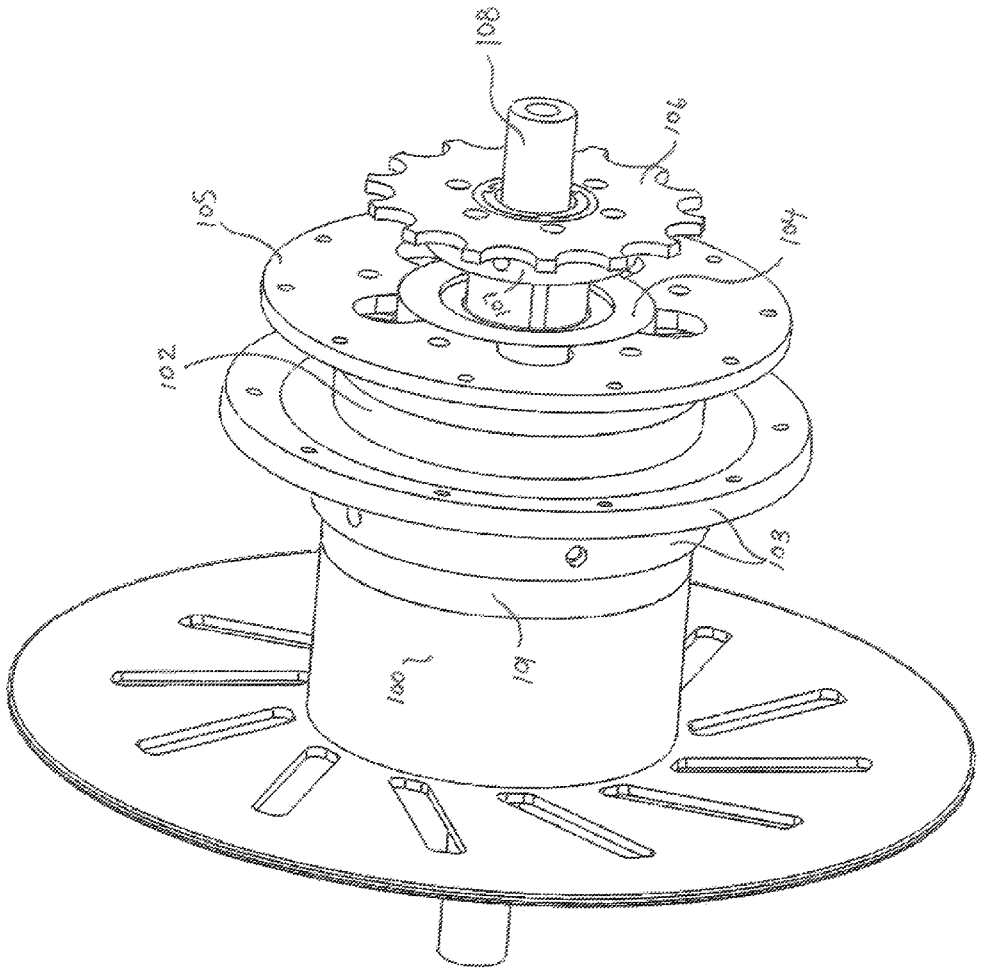


FIG. 1A

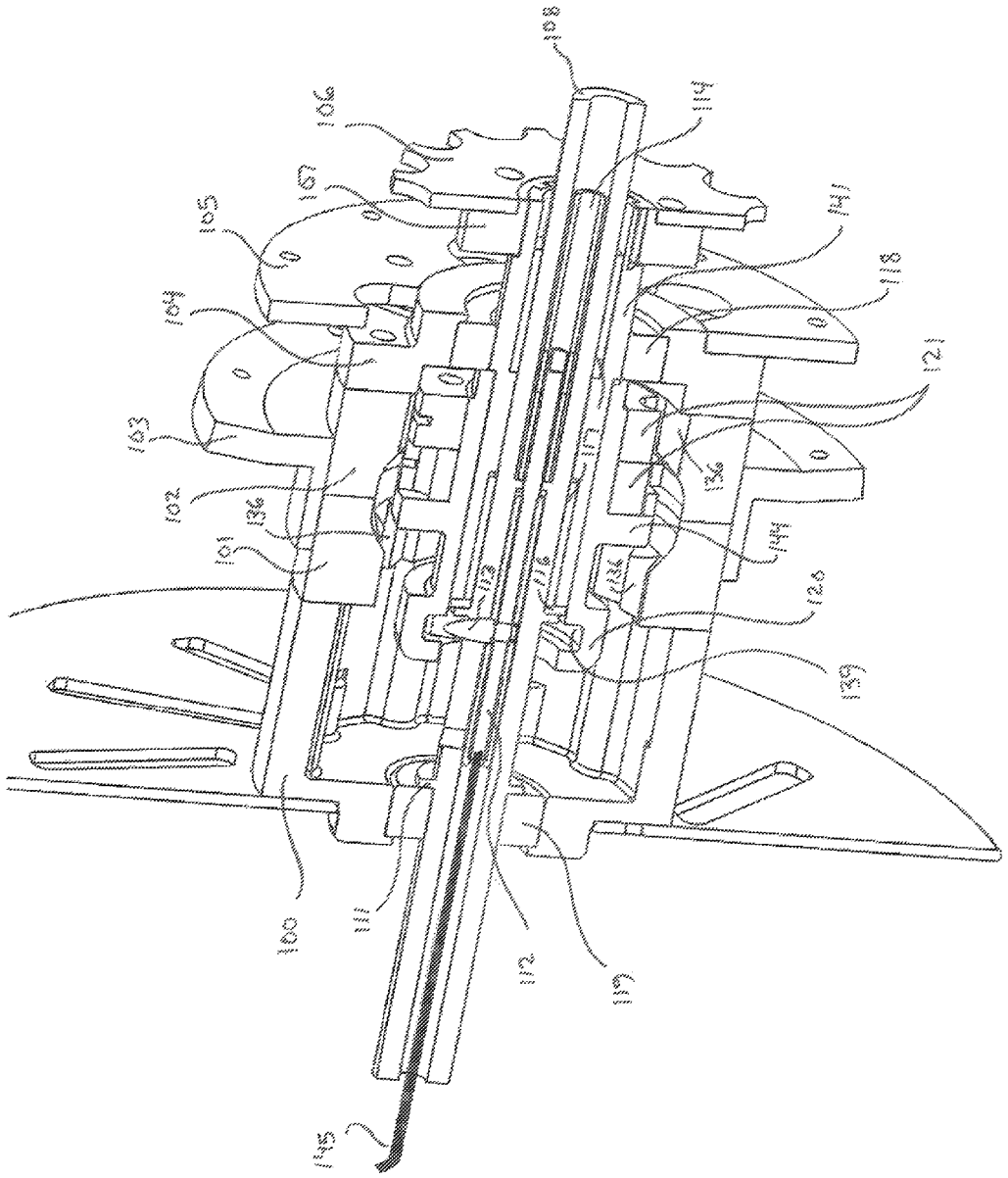

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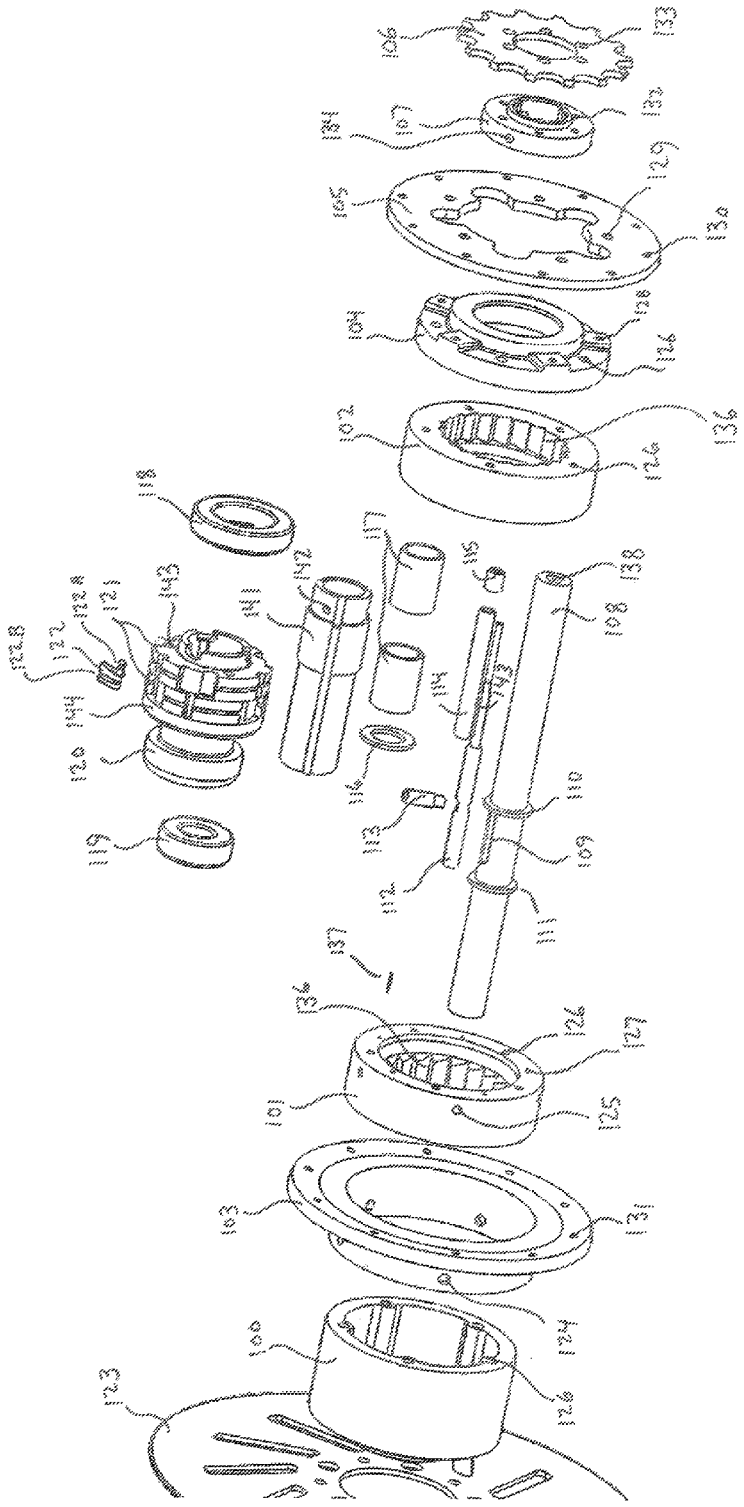
FIG. 5



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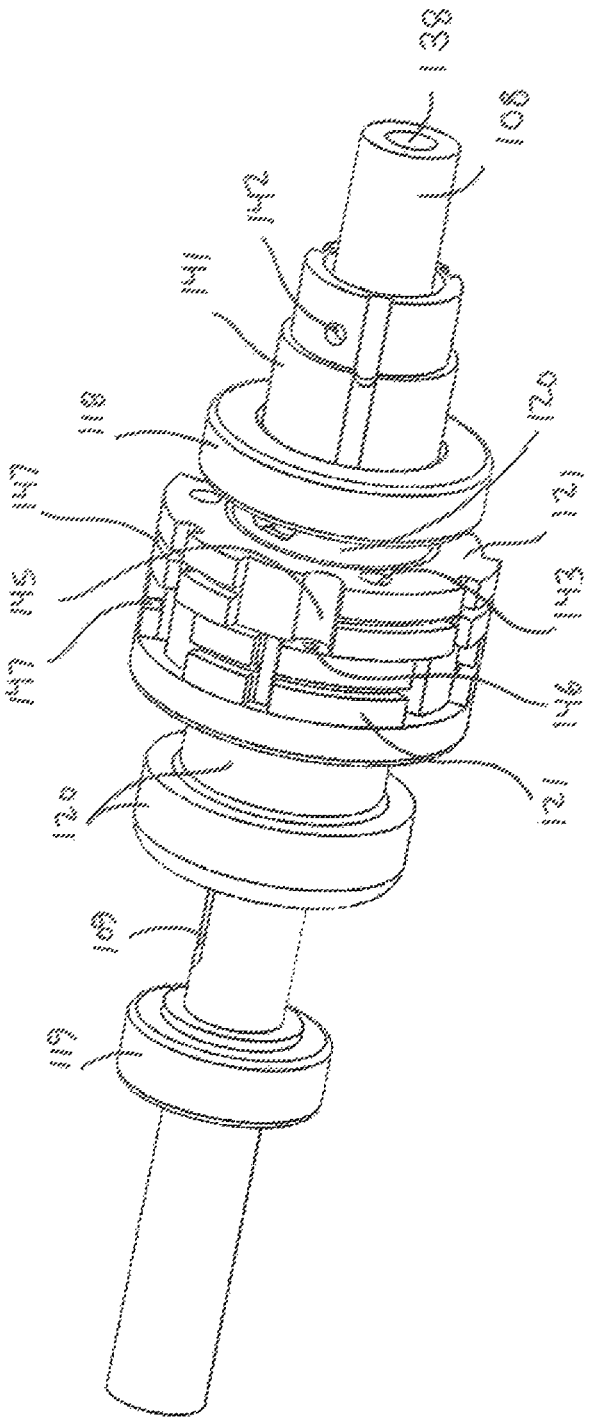

FIG. 7

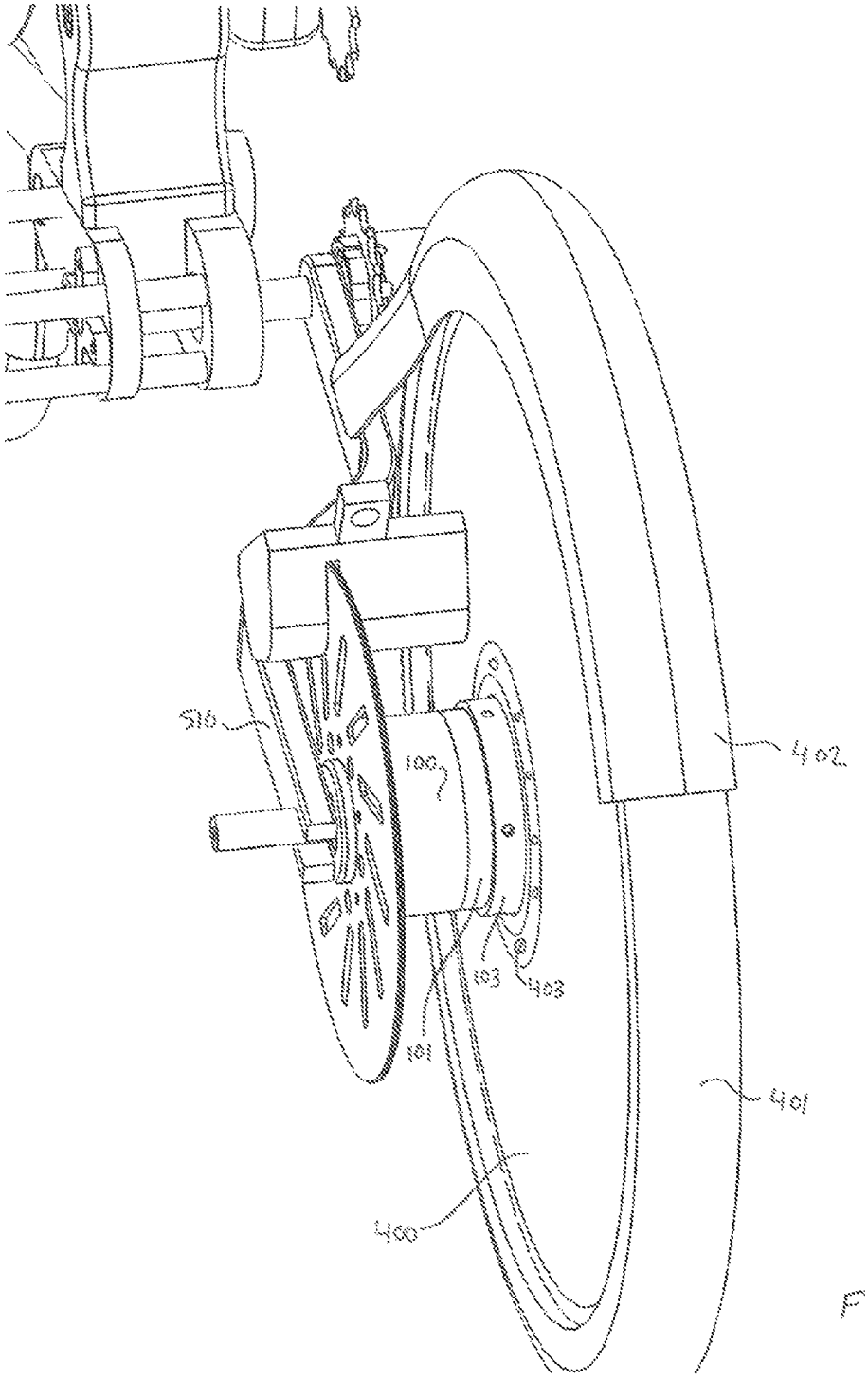

FIG. 8

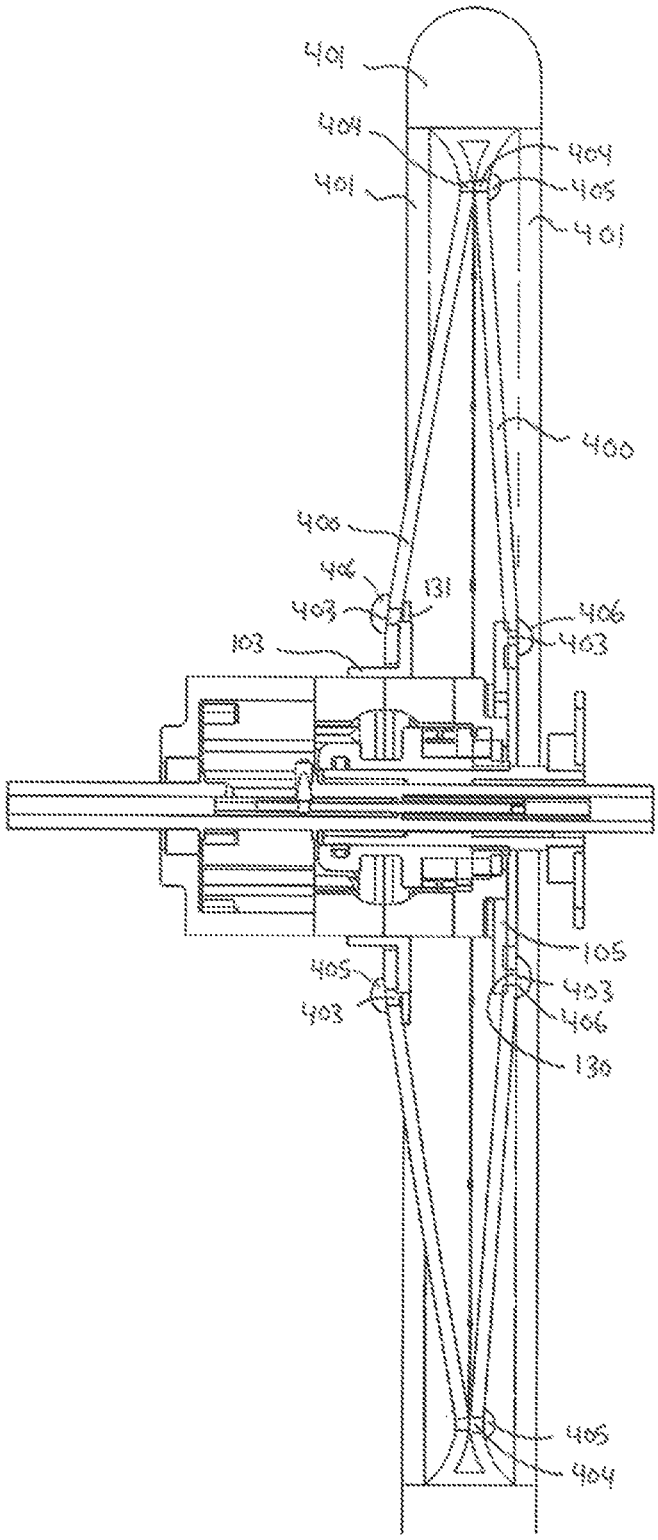
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FIG. 9

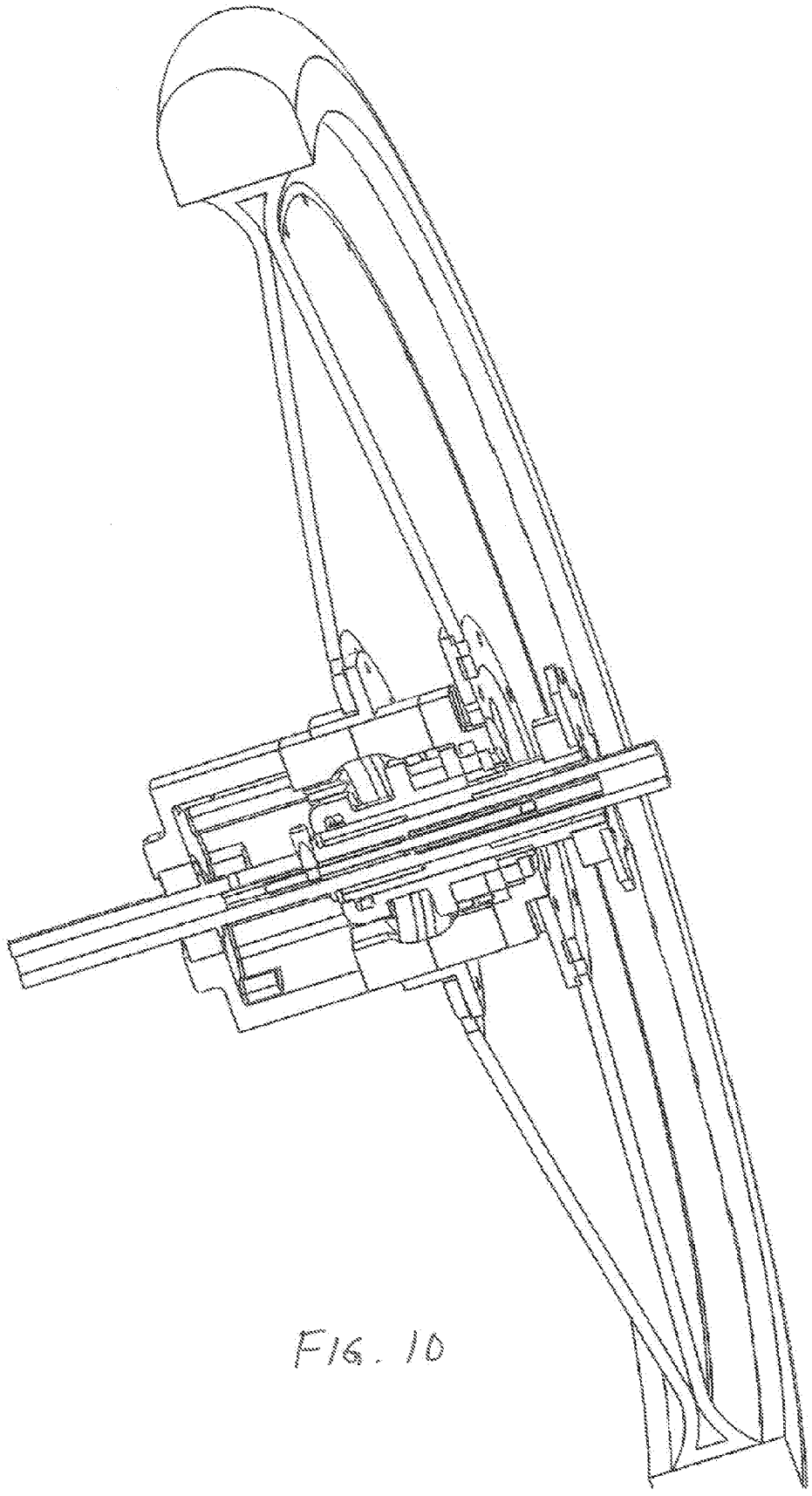


FIG. 10

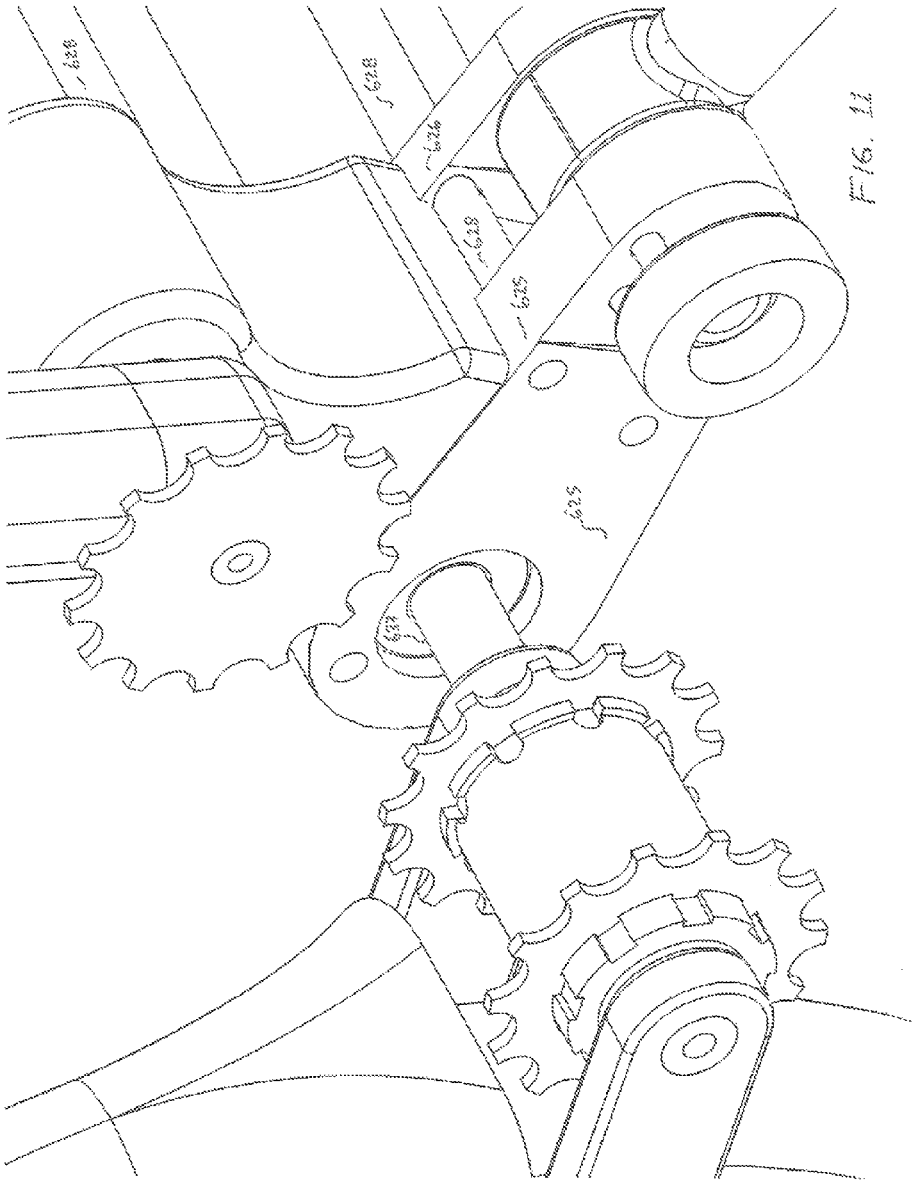


FIG. 11

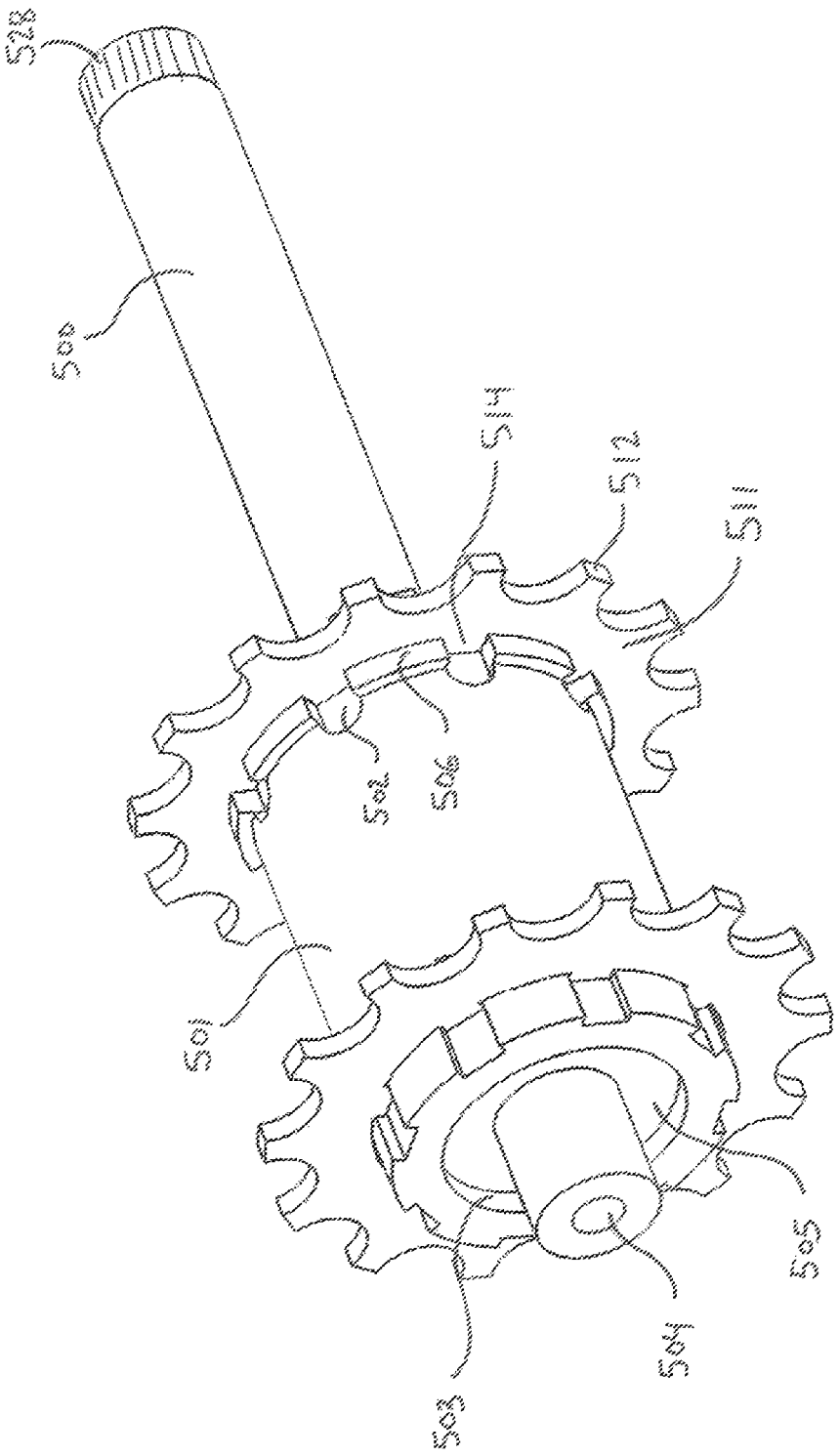
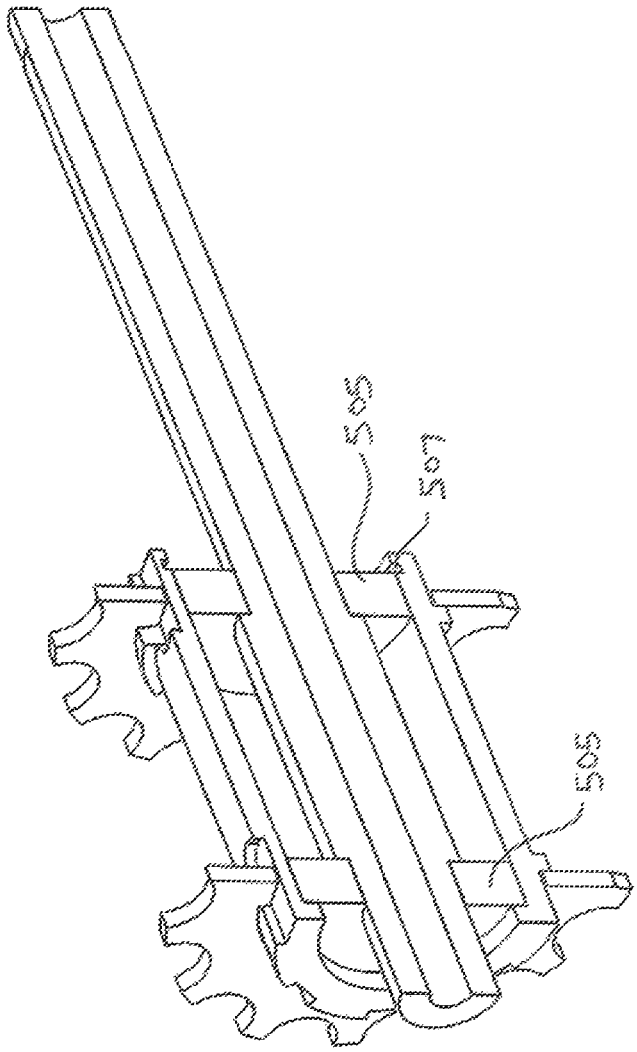
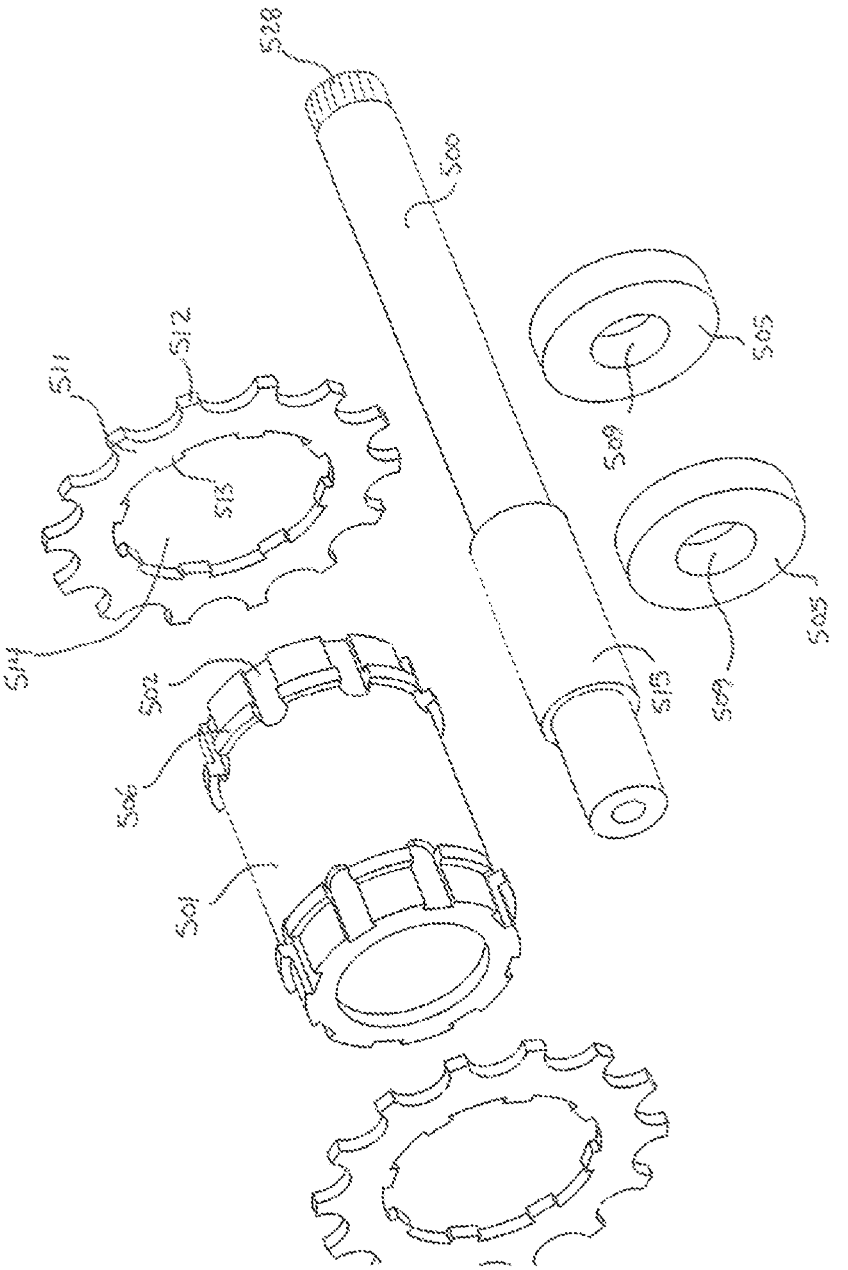


FIG. 12

Fig. 12





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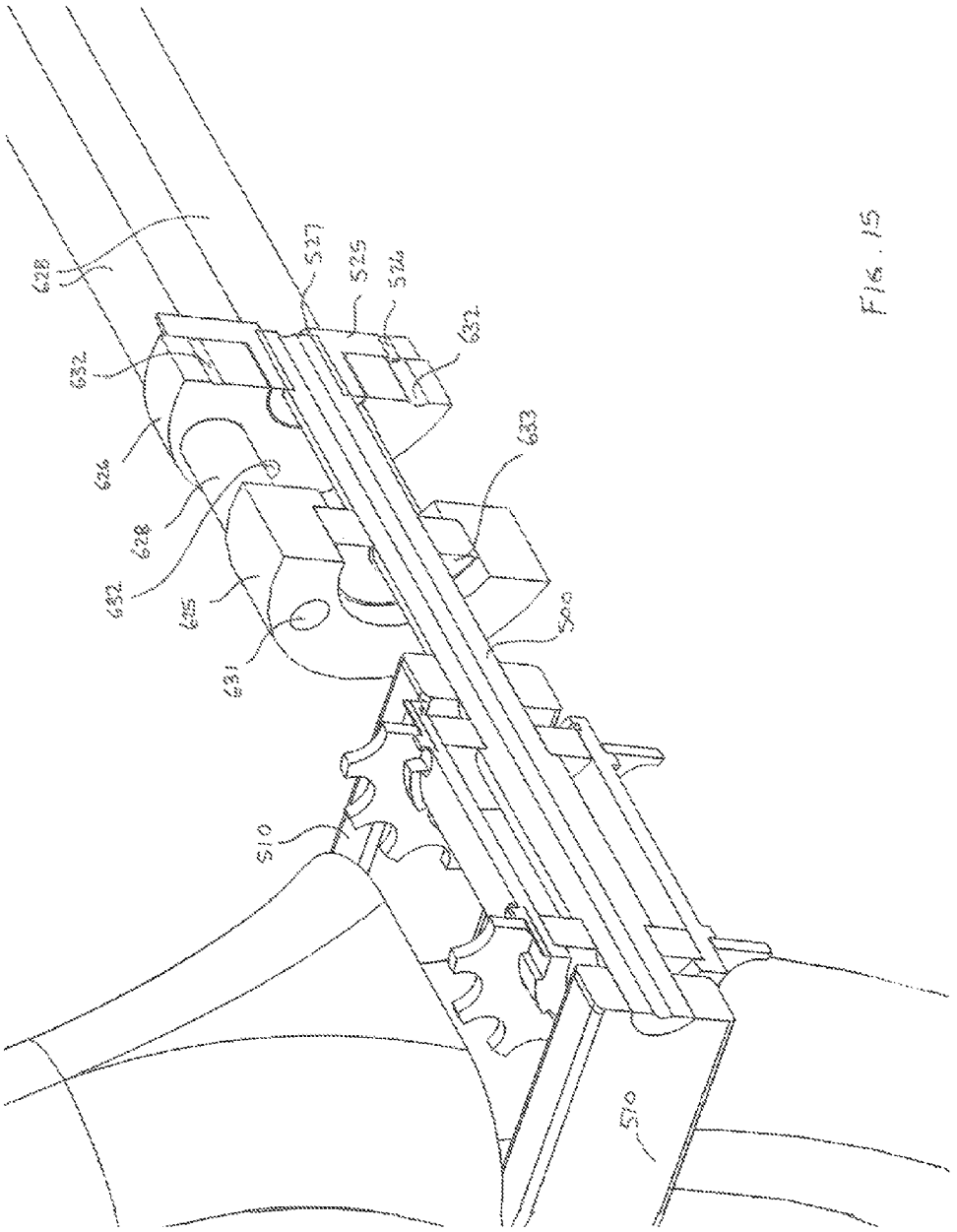

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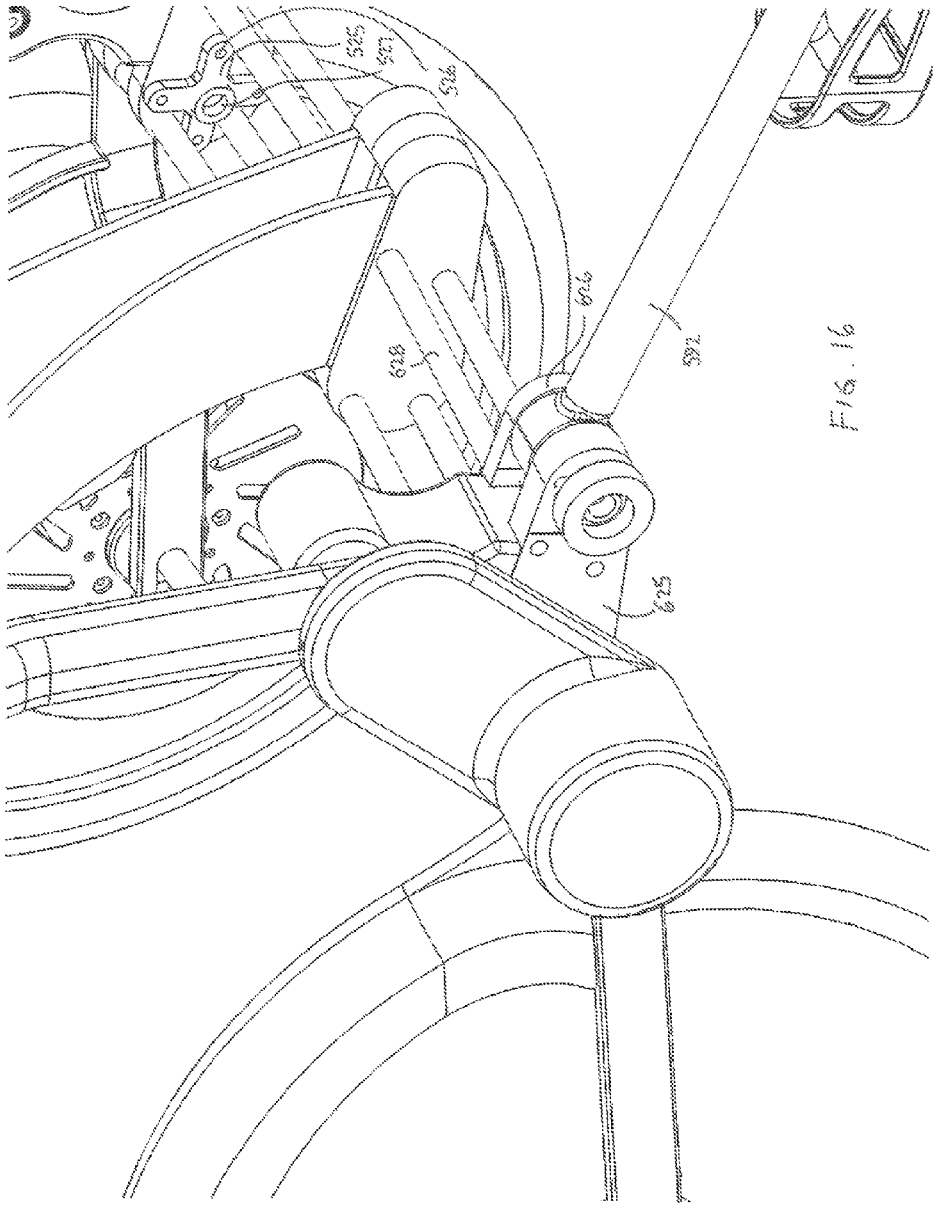


FIG. 16

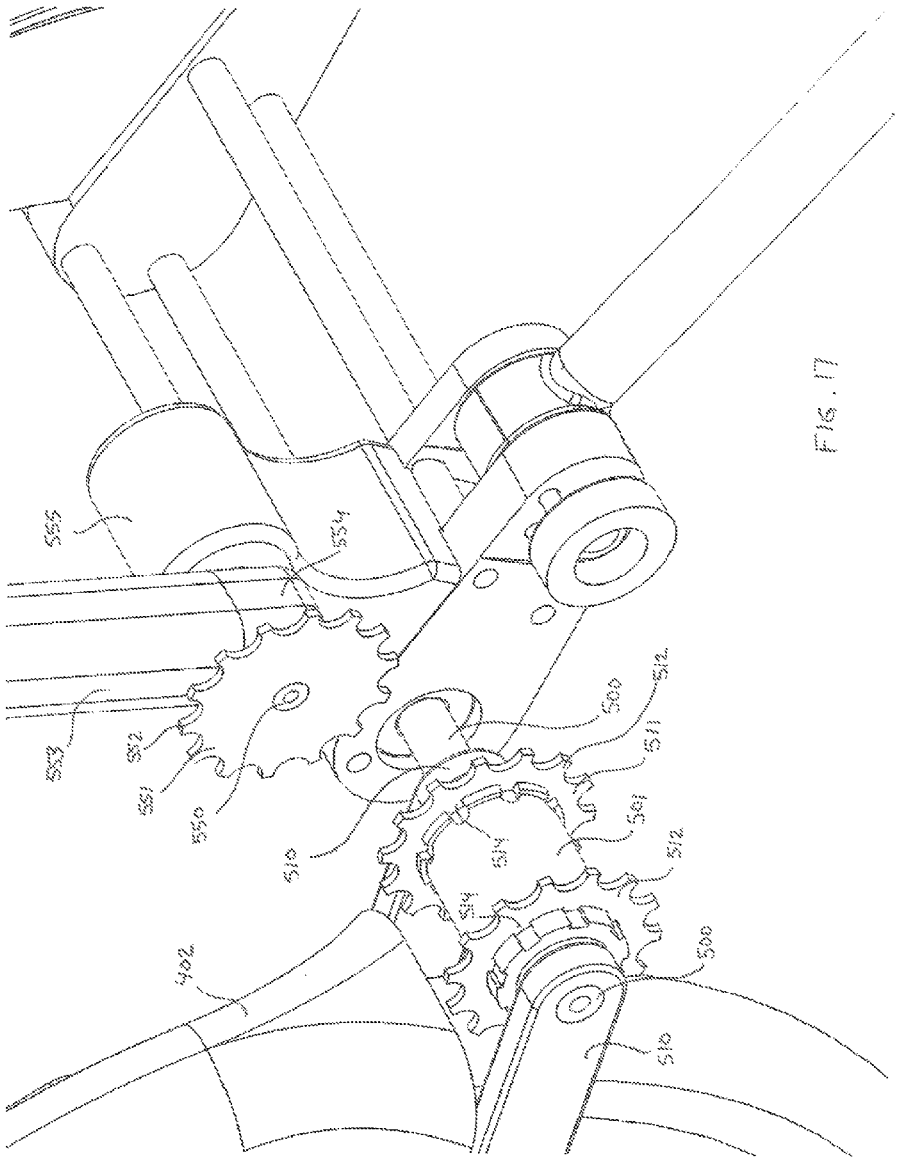
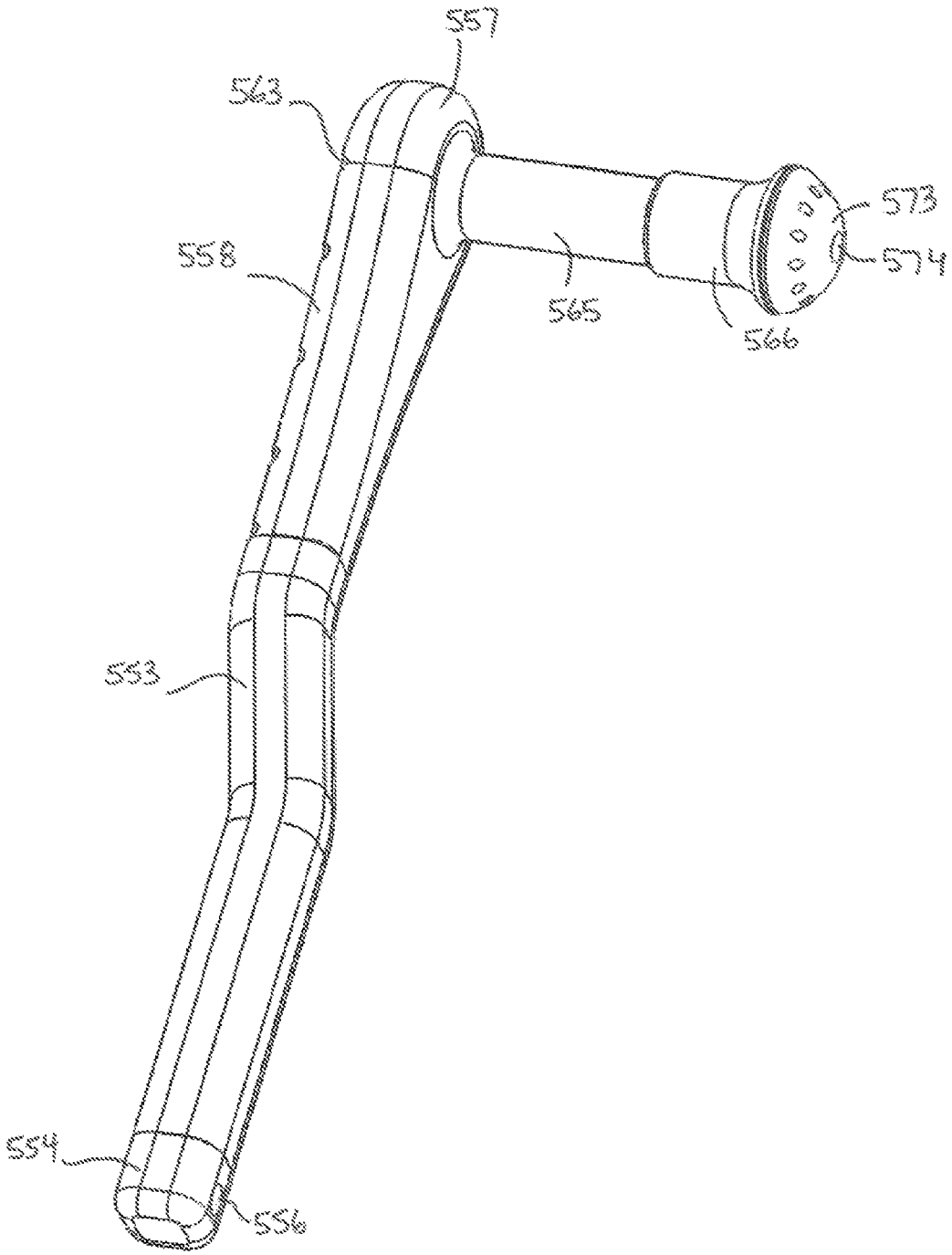


FIG. 17



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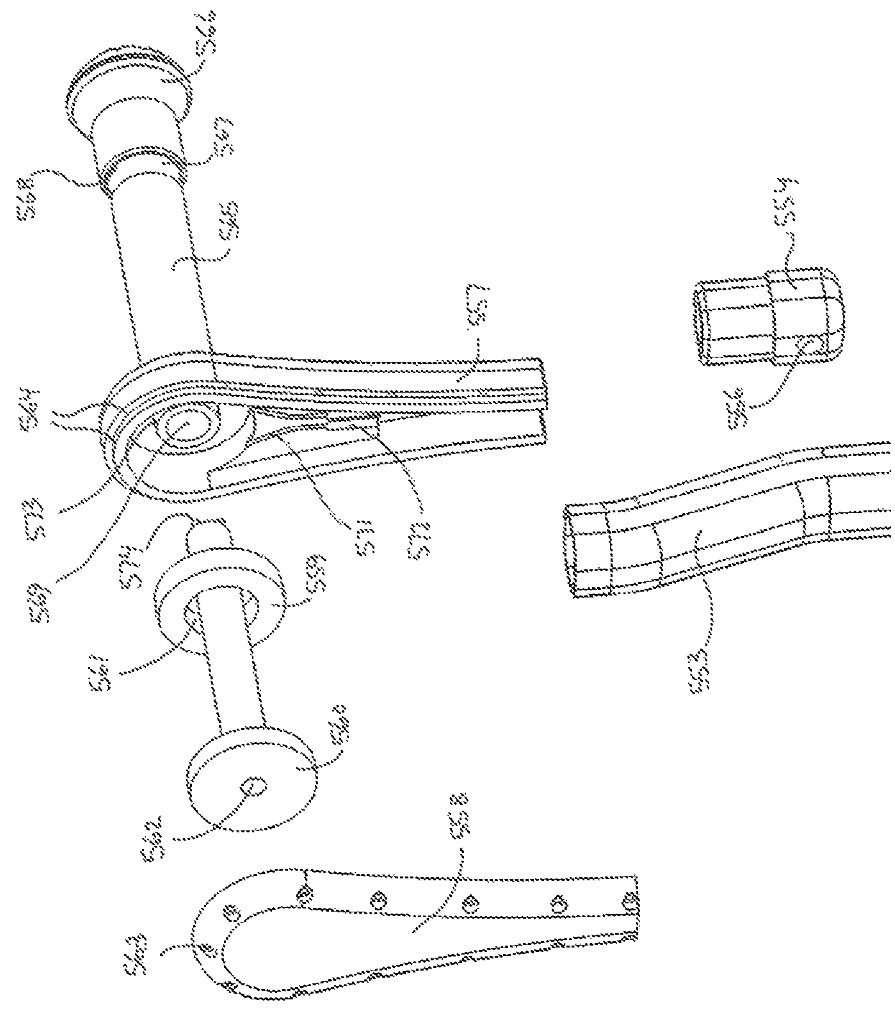
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FIG. 19

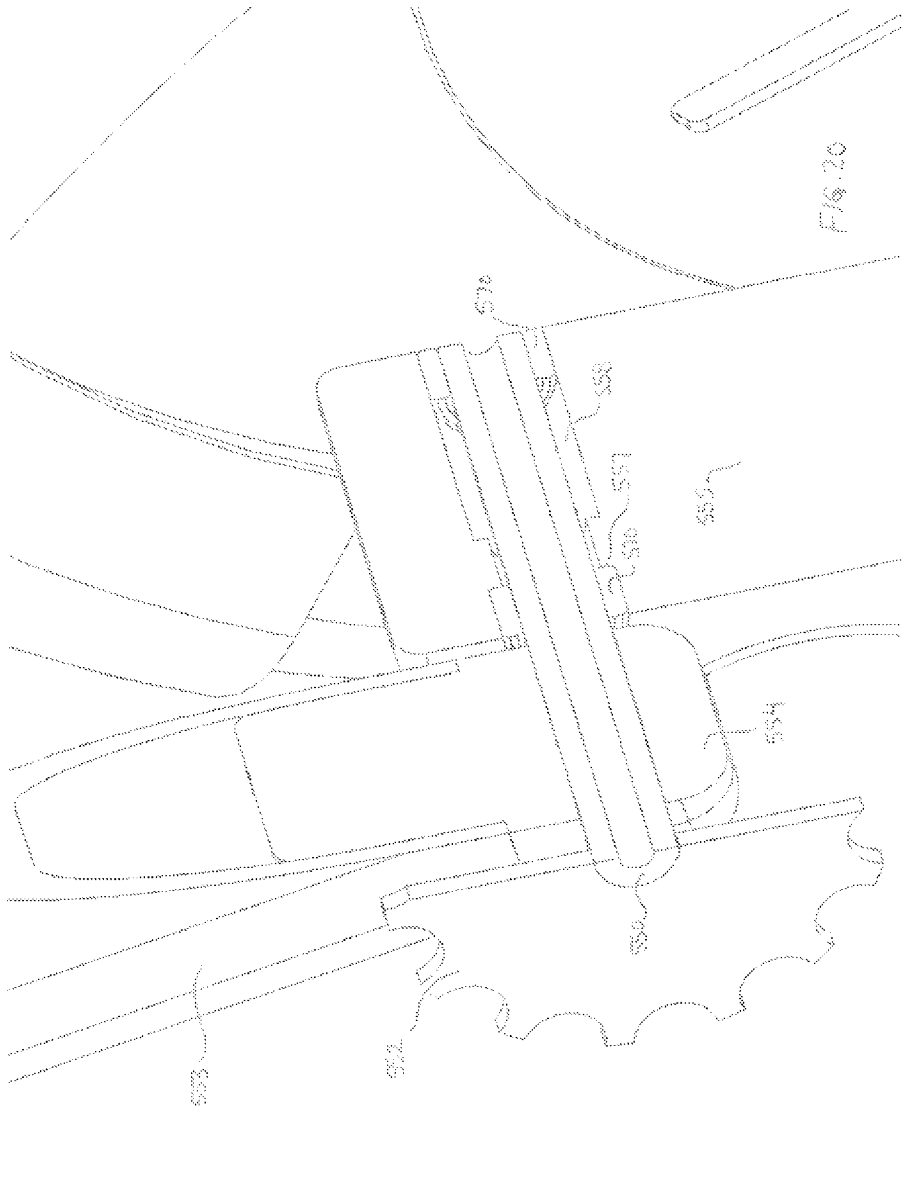


FIG. 20

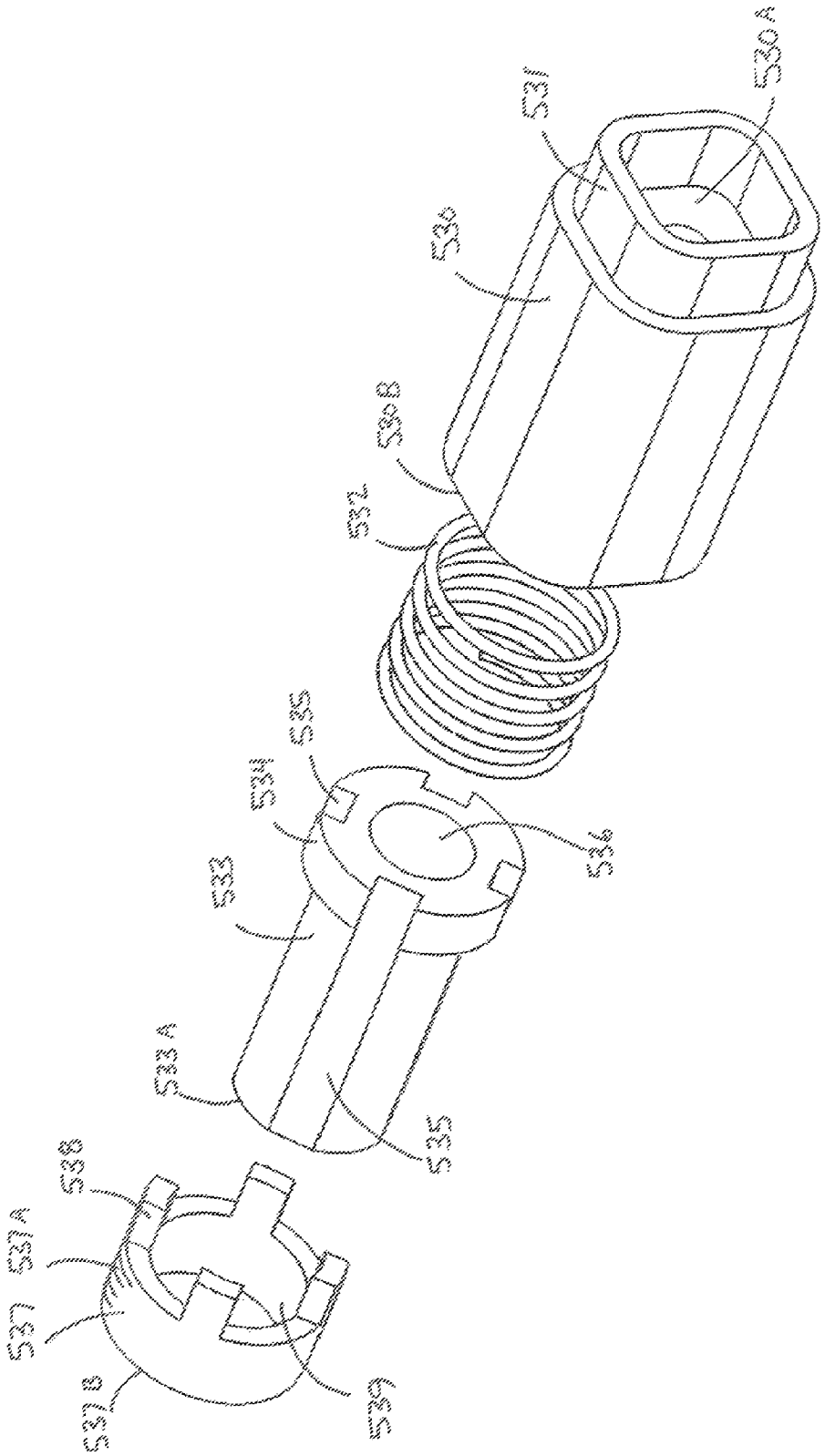


FIG. 21

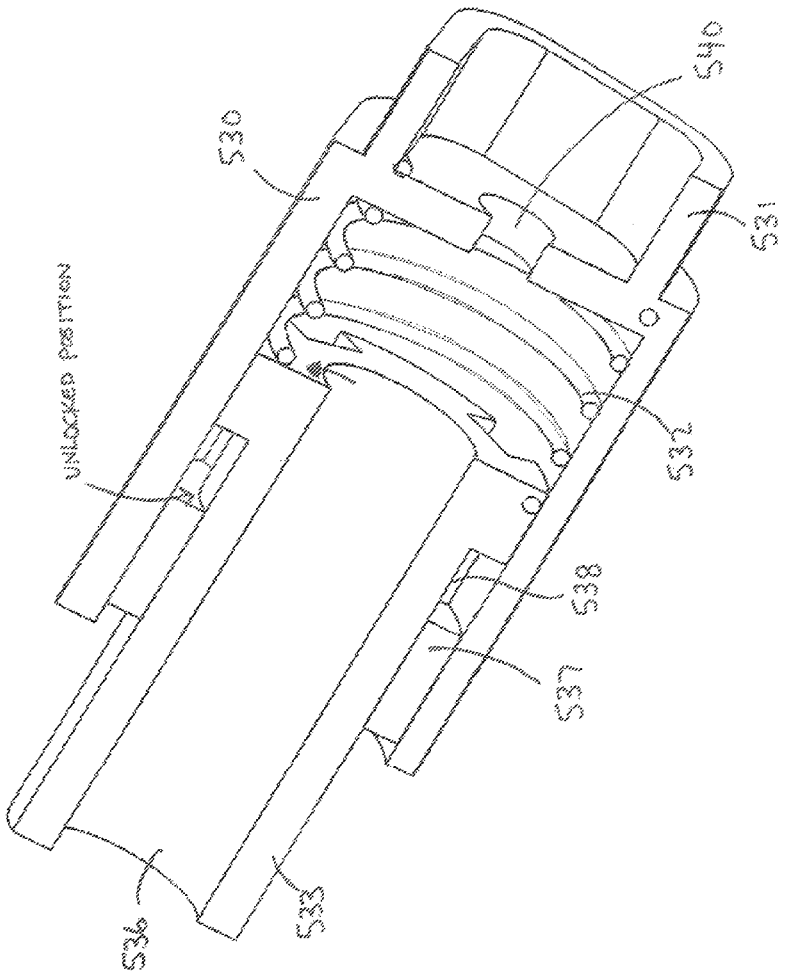
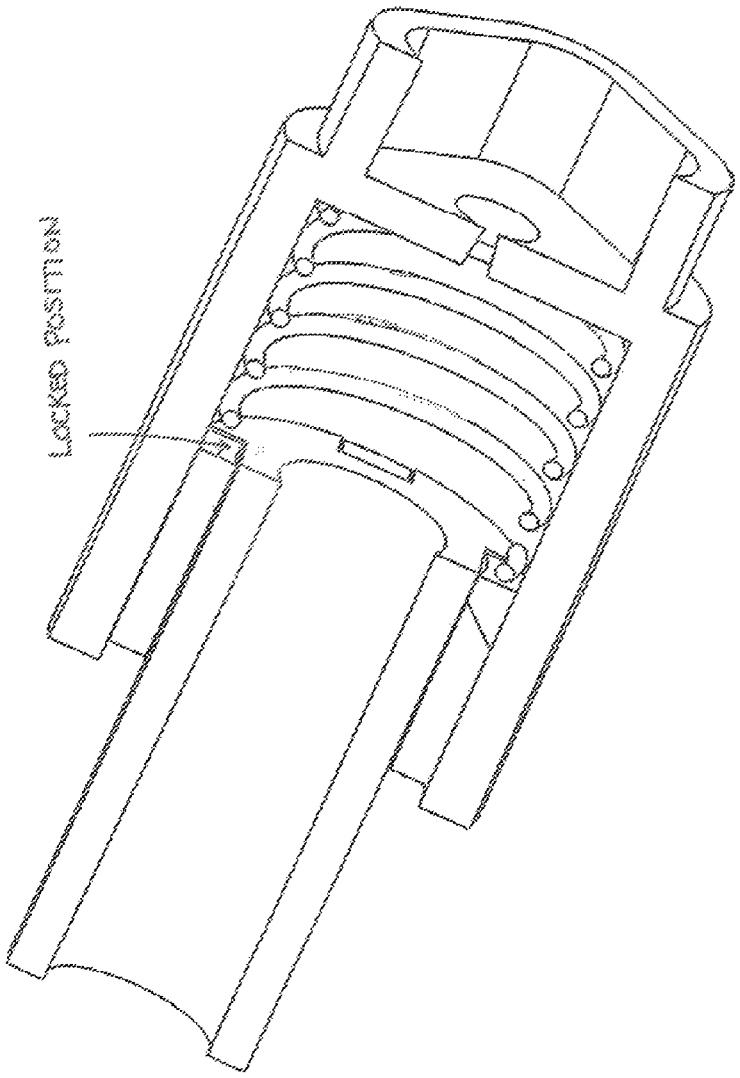


FIG. 22



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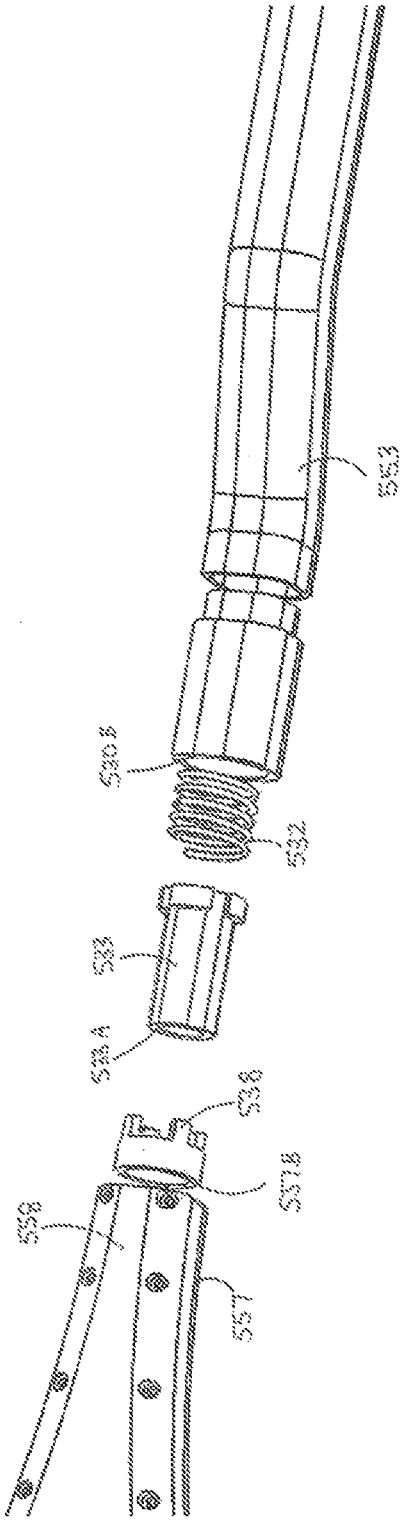
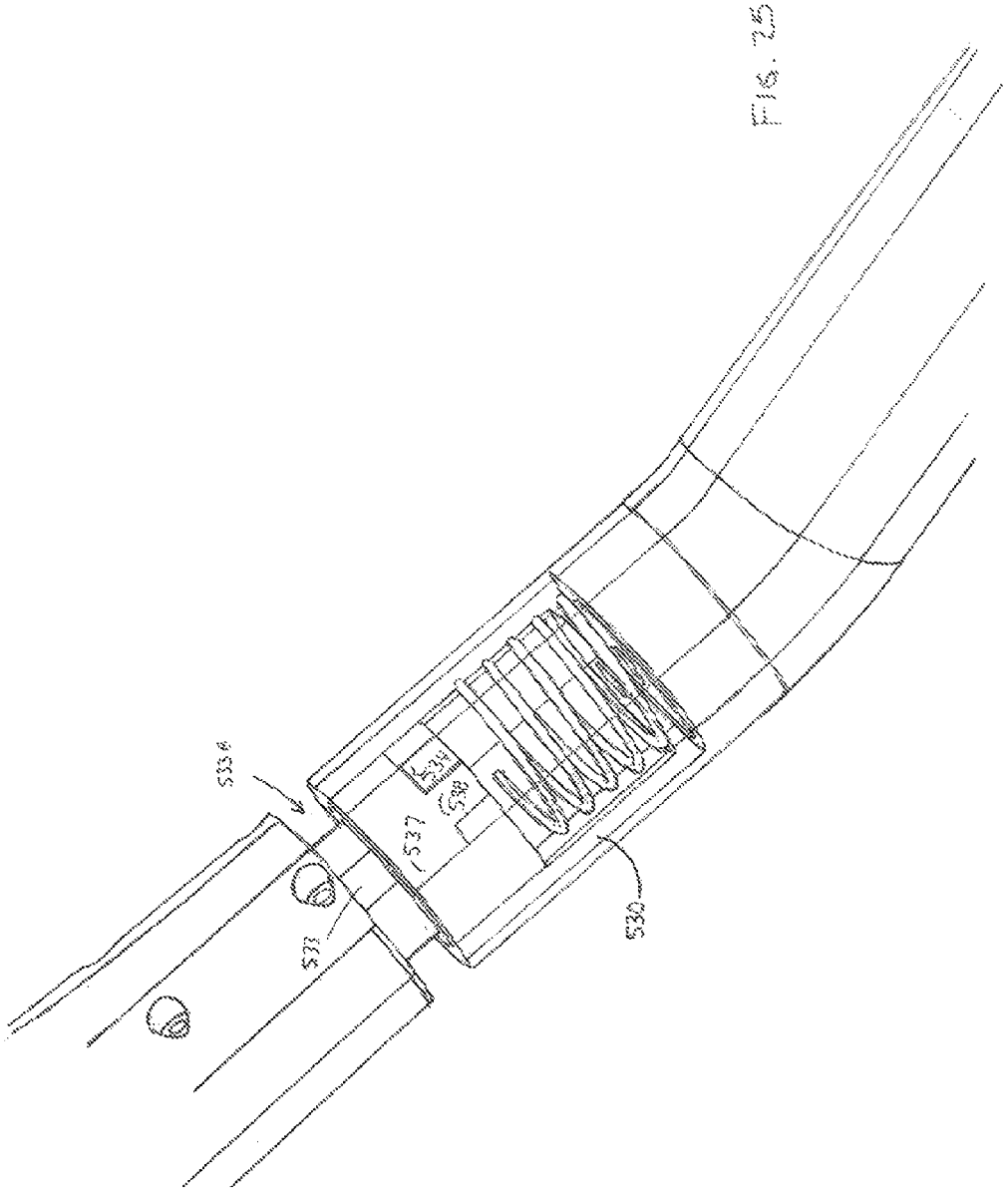


FIG. 24

FIG. 25



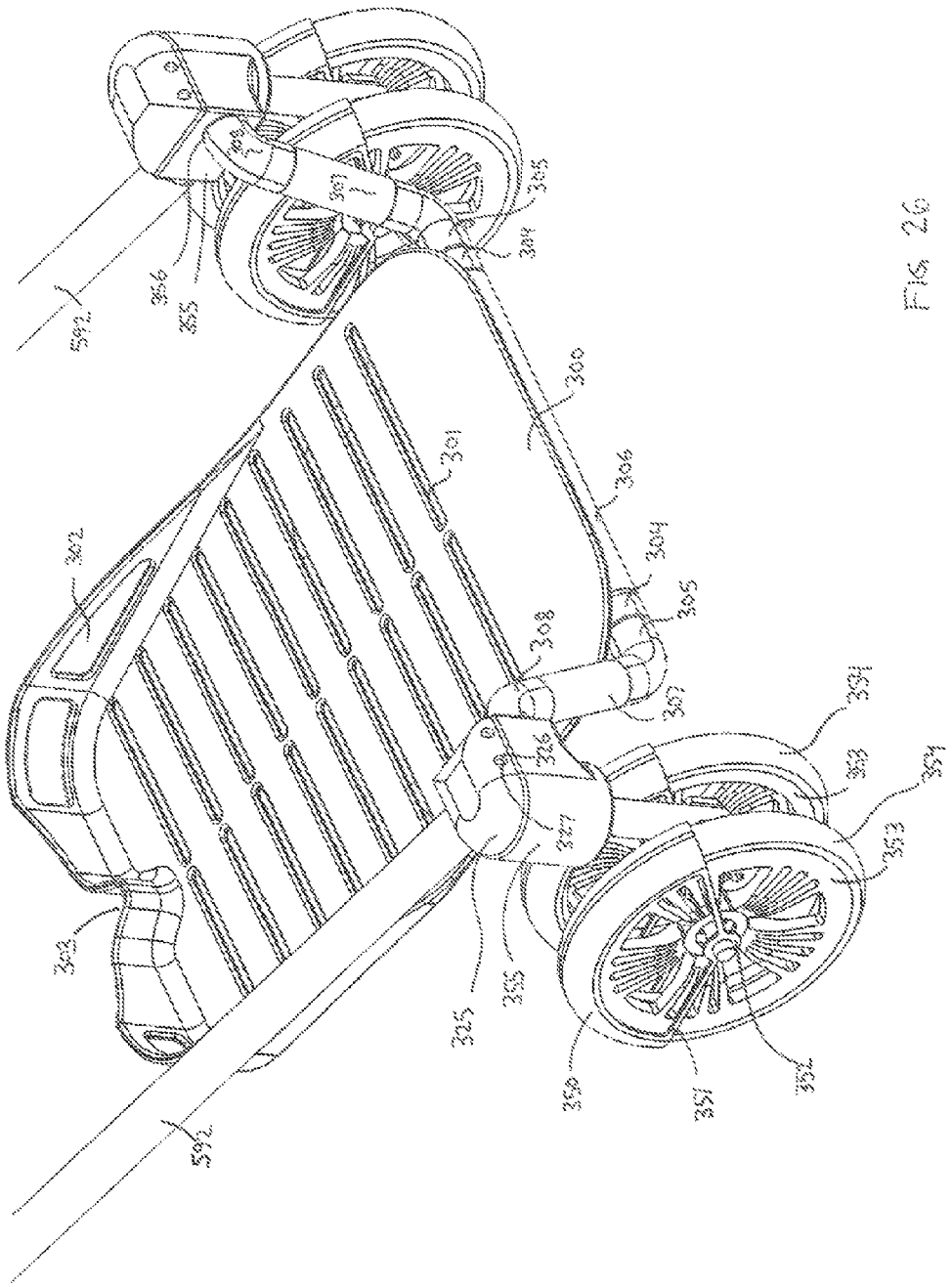

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FIG. 26

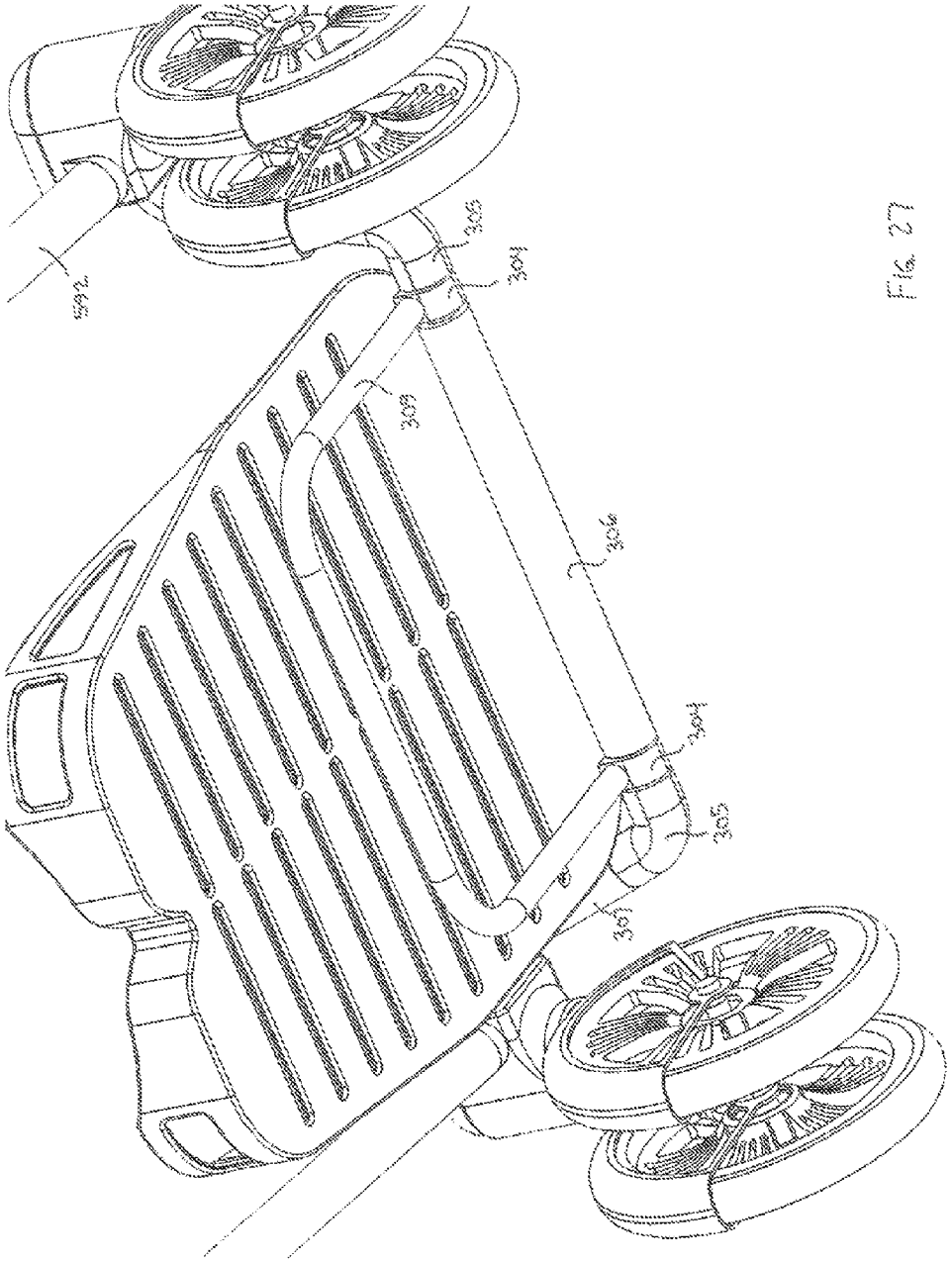

Fig. 27

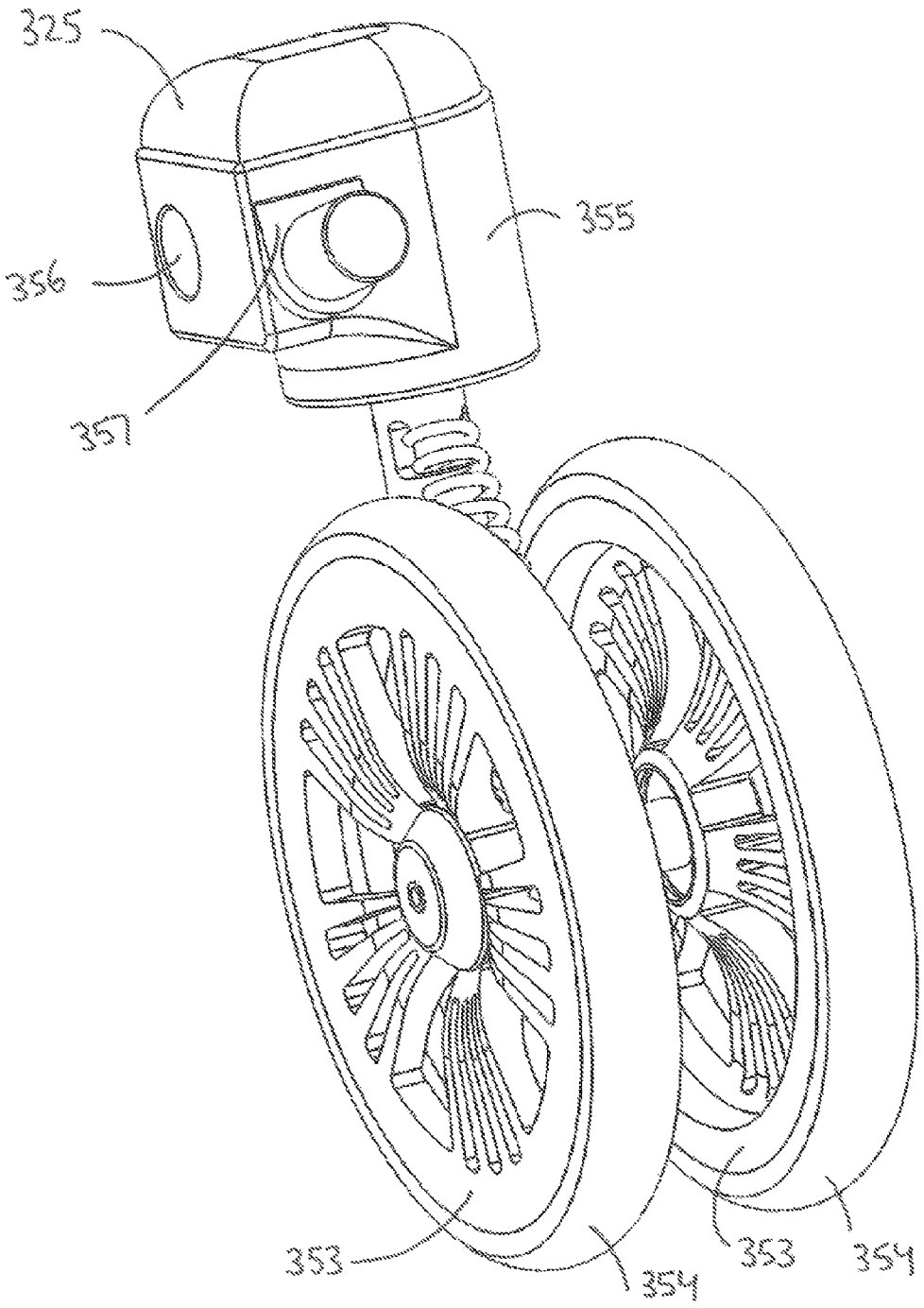

FIG. 28

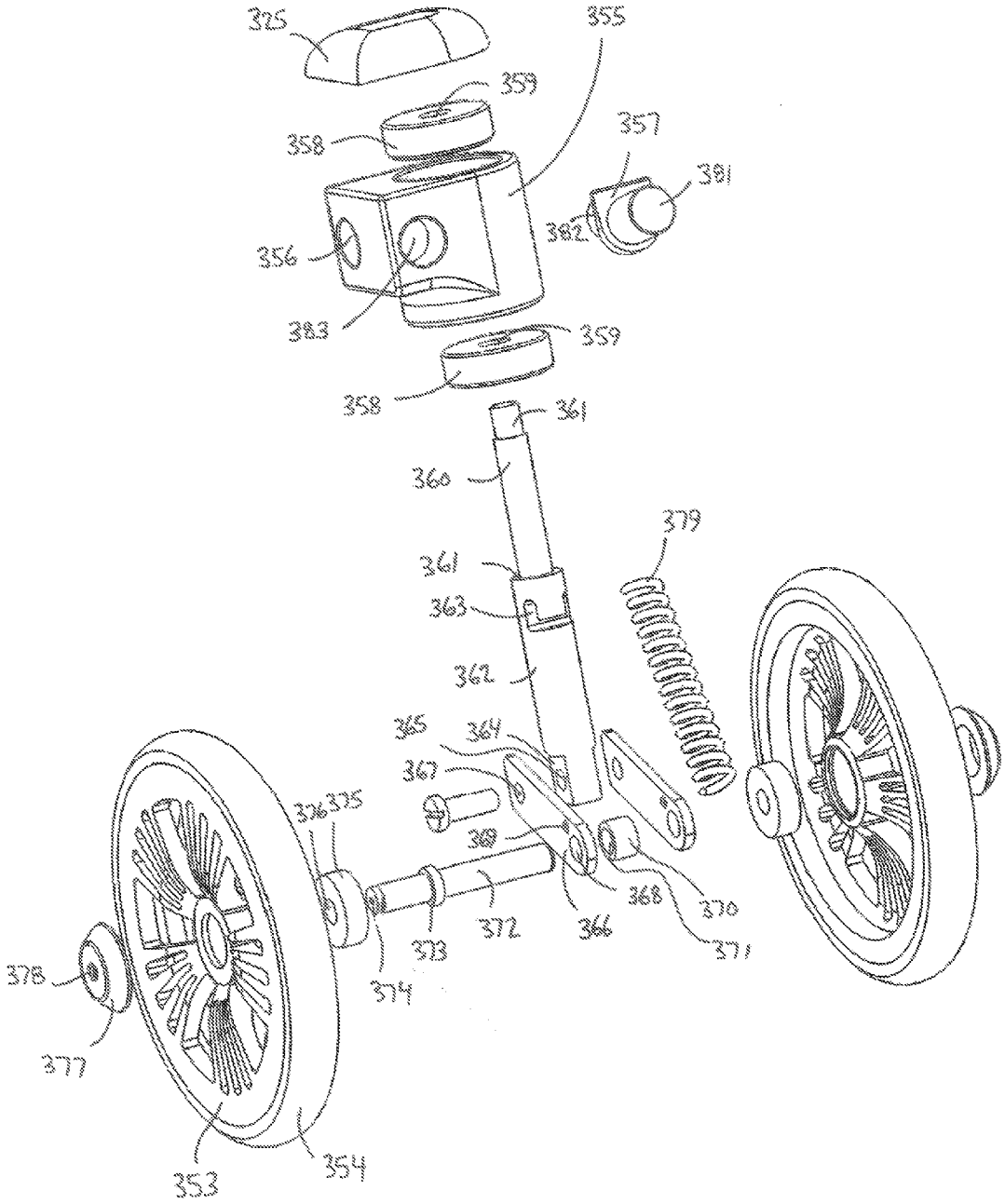
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FIG. 29

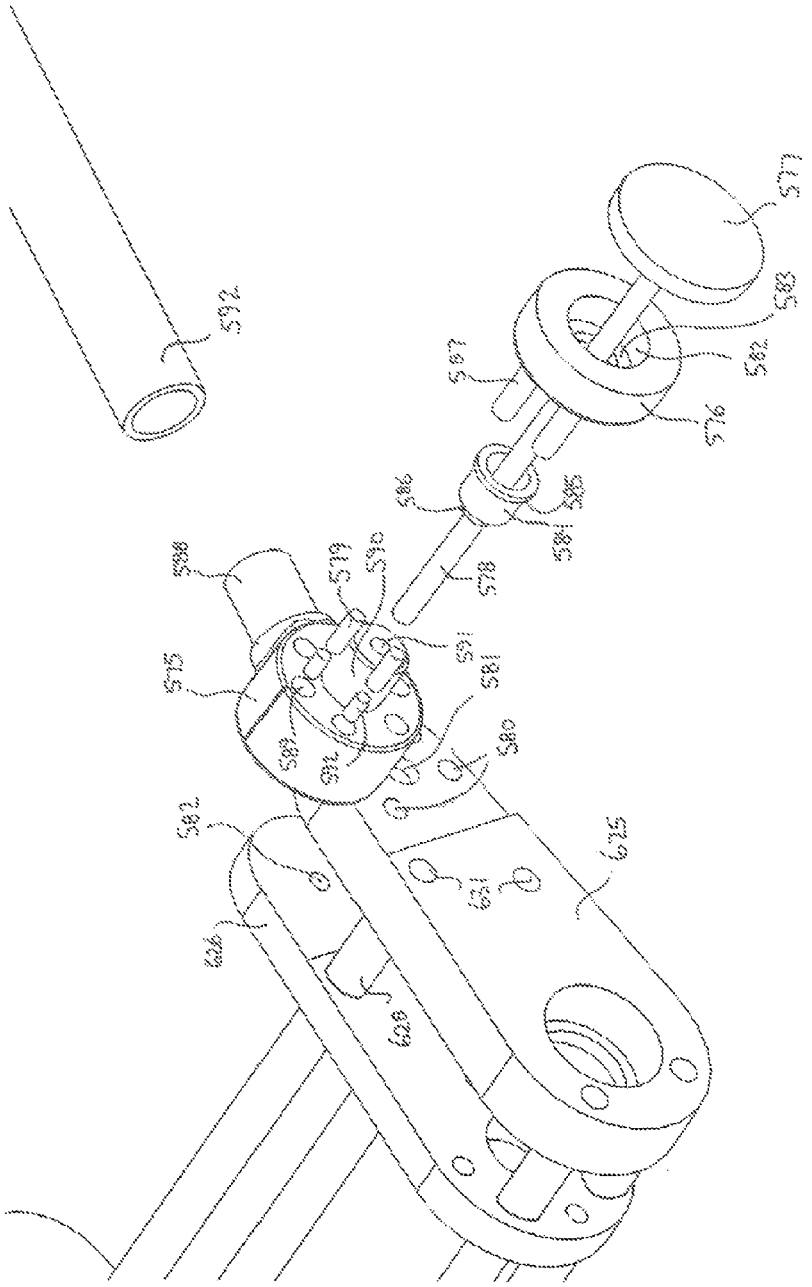
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FIG. 30

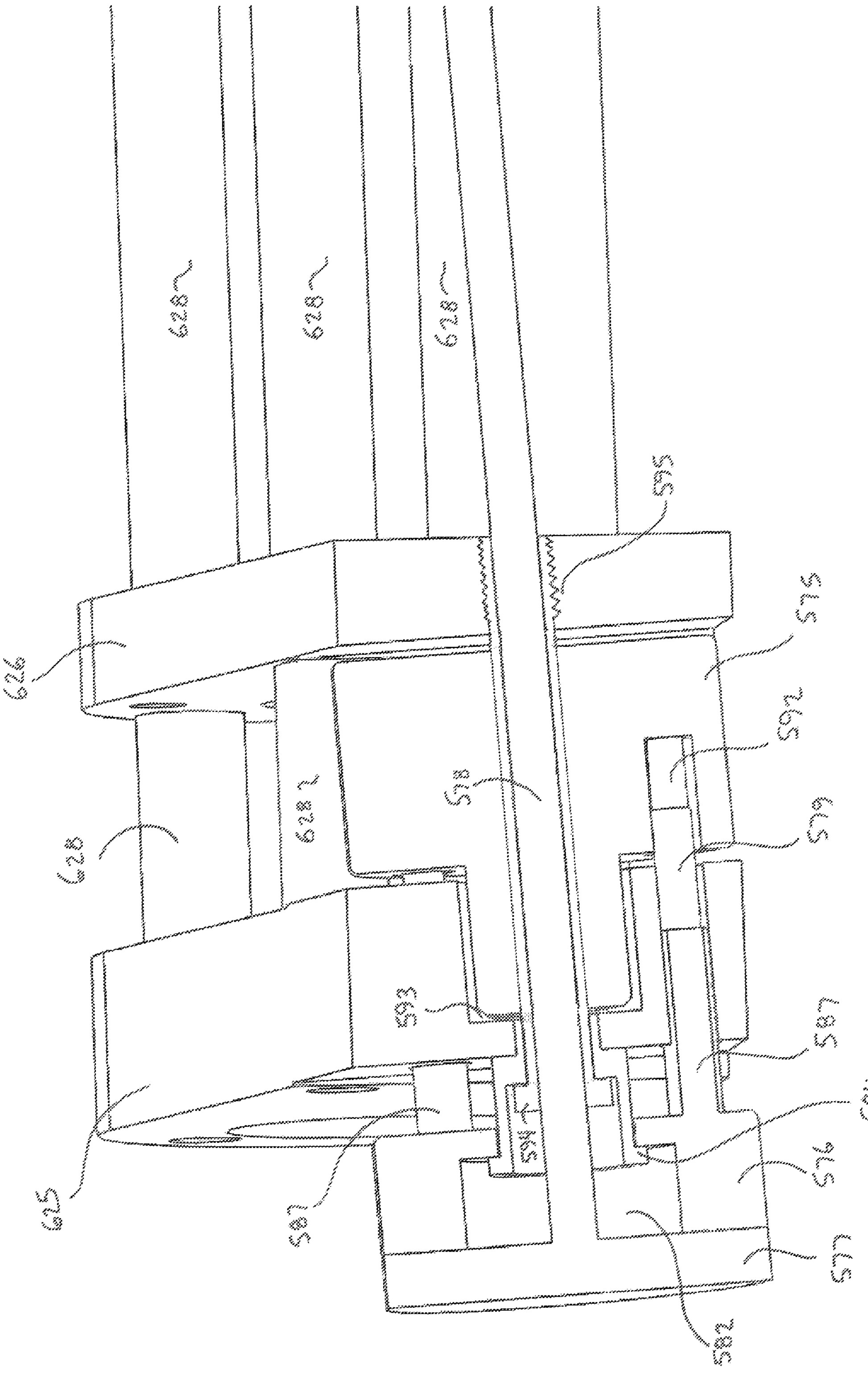
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FIG. 31

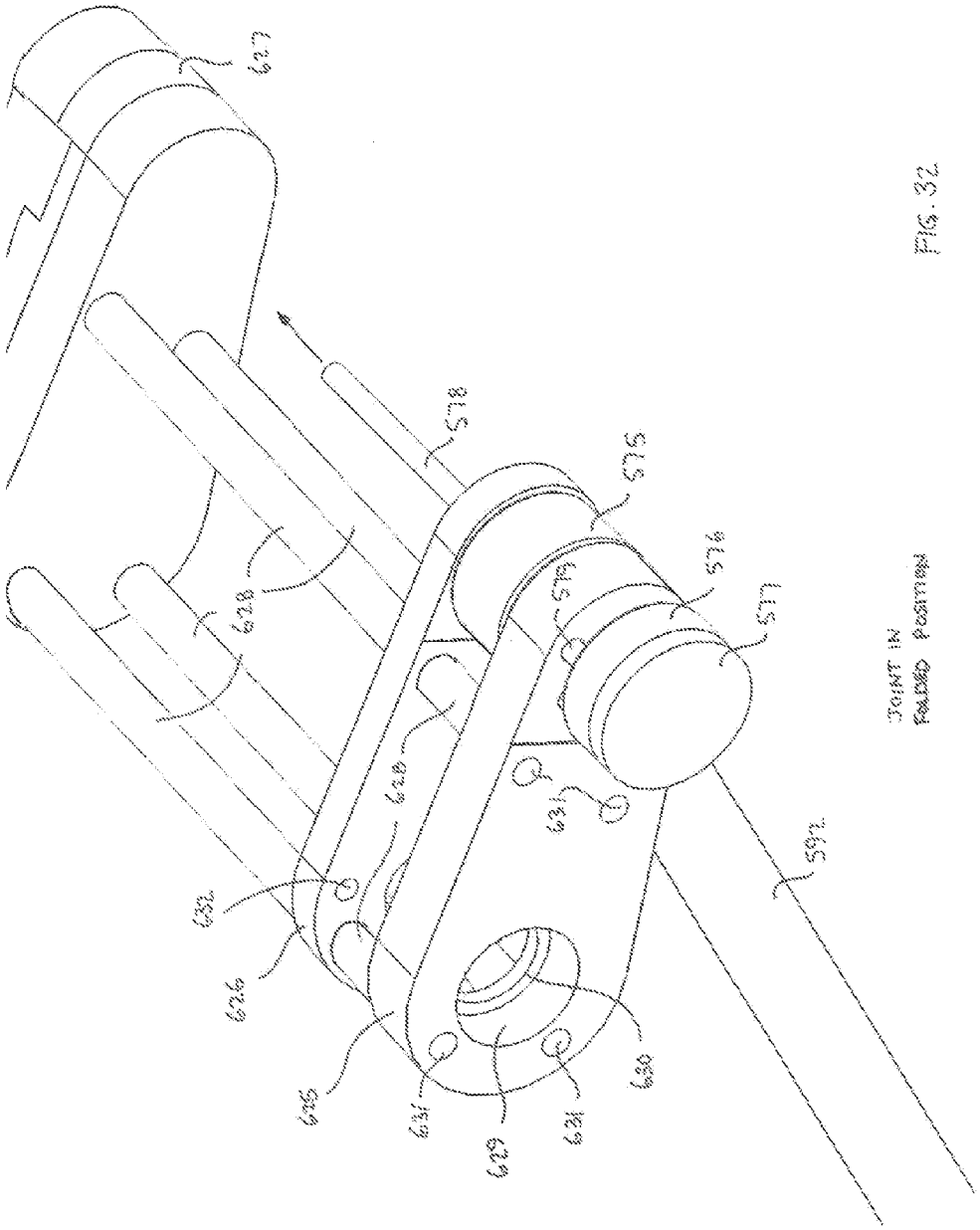
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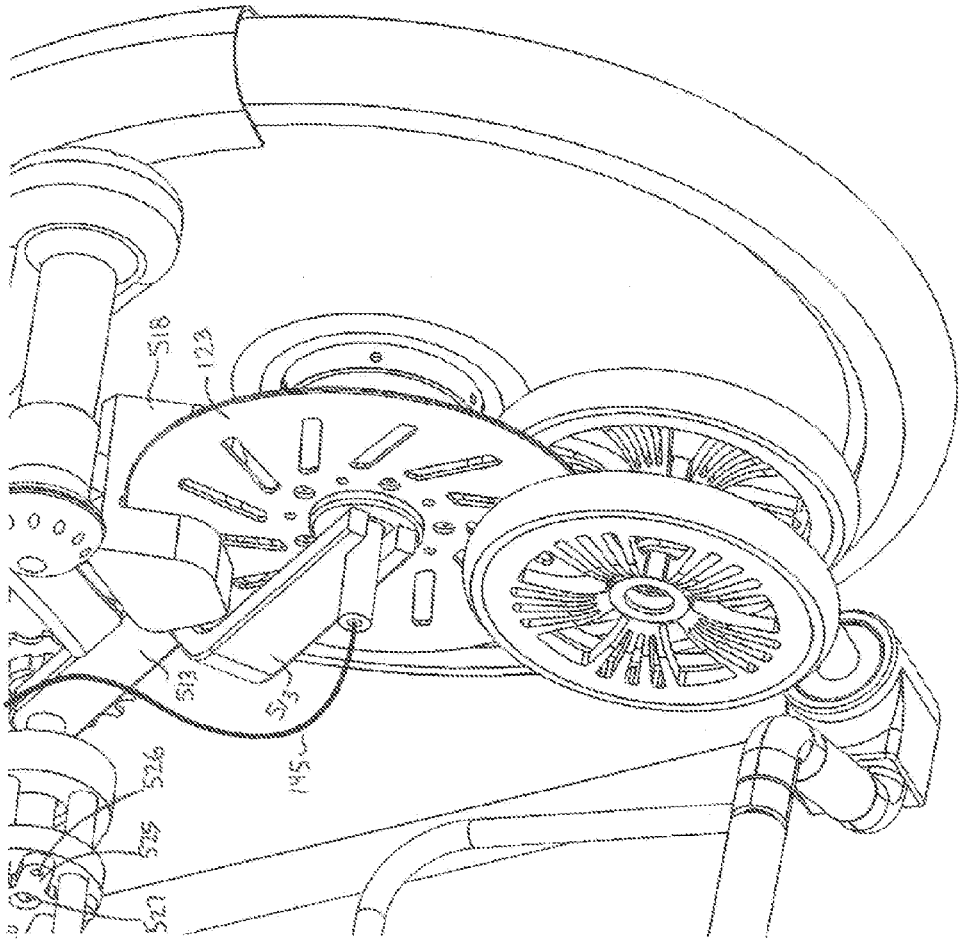
FIG. 32

FIG. 33



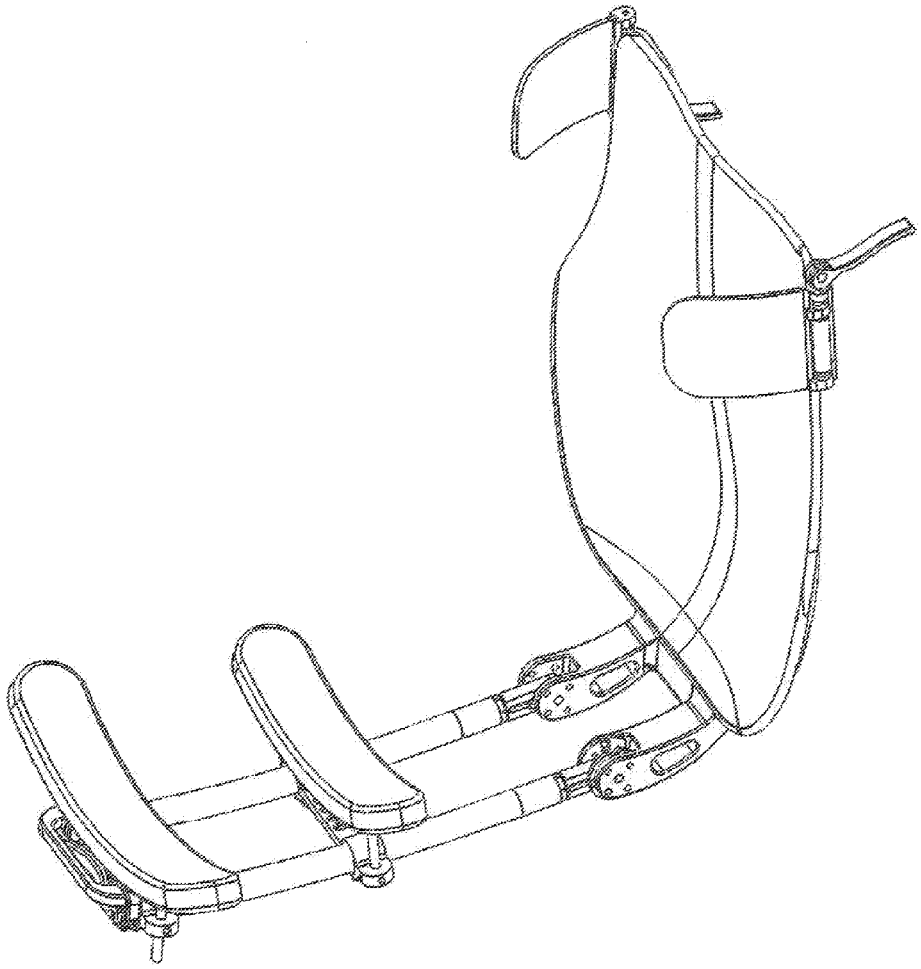


FIG. 34

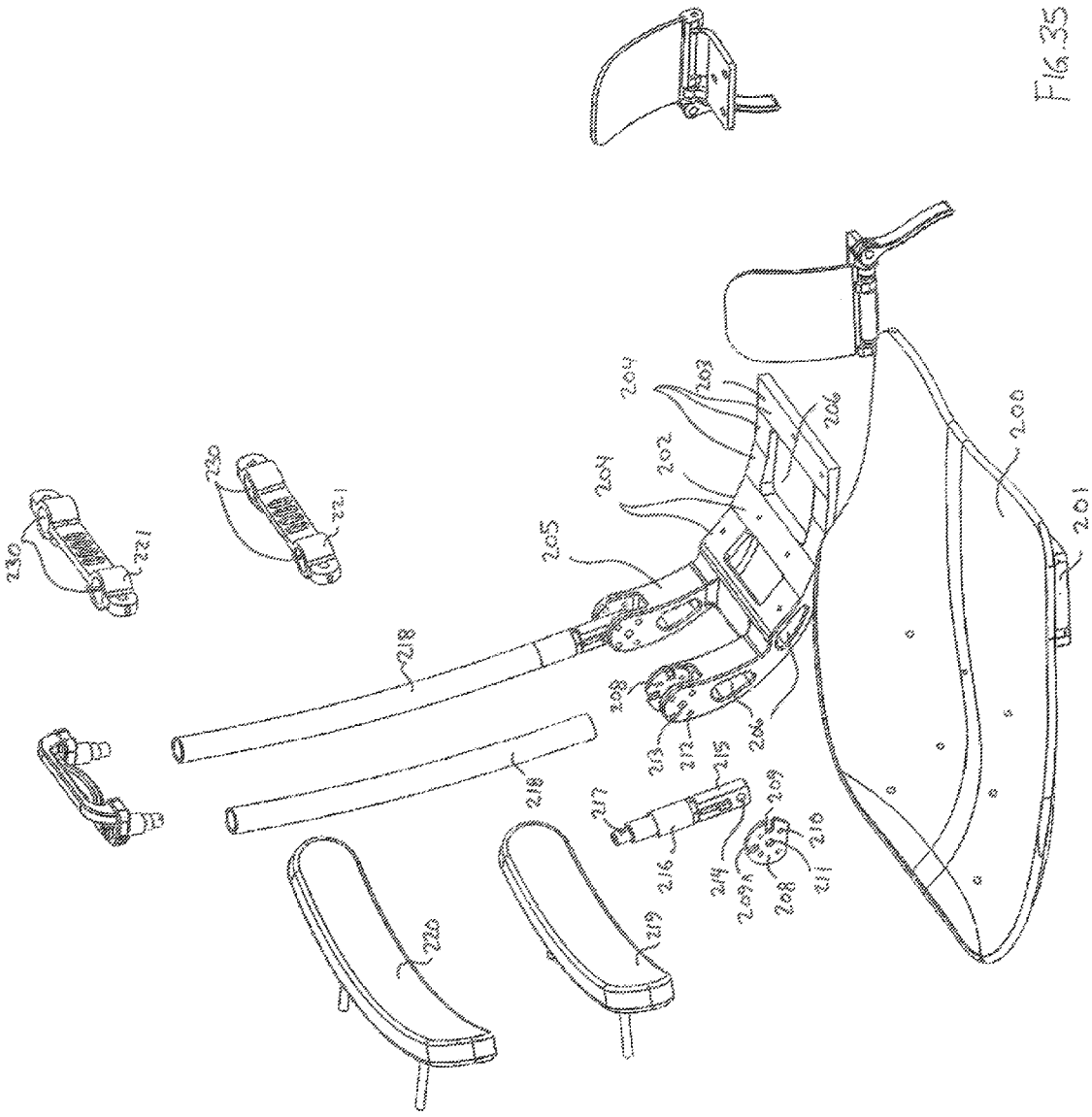

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Fig. 35

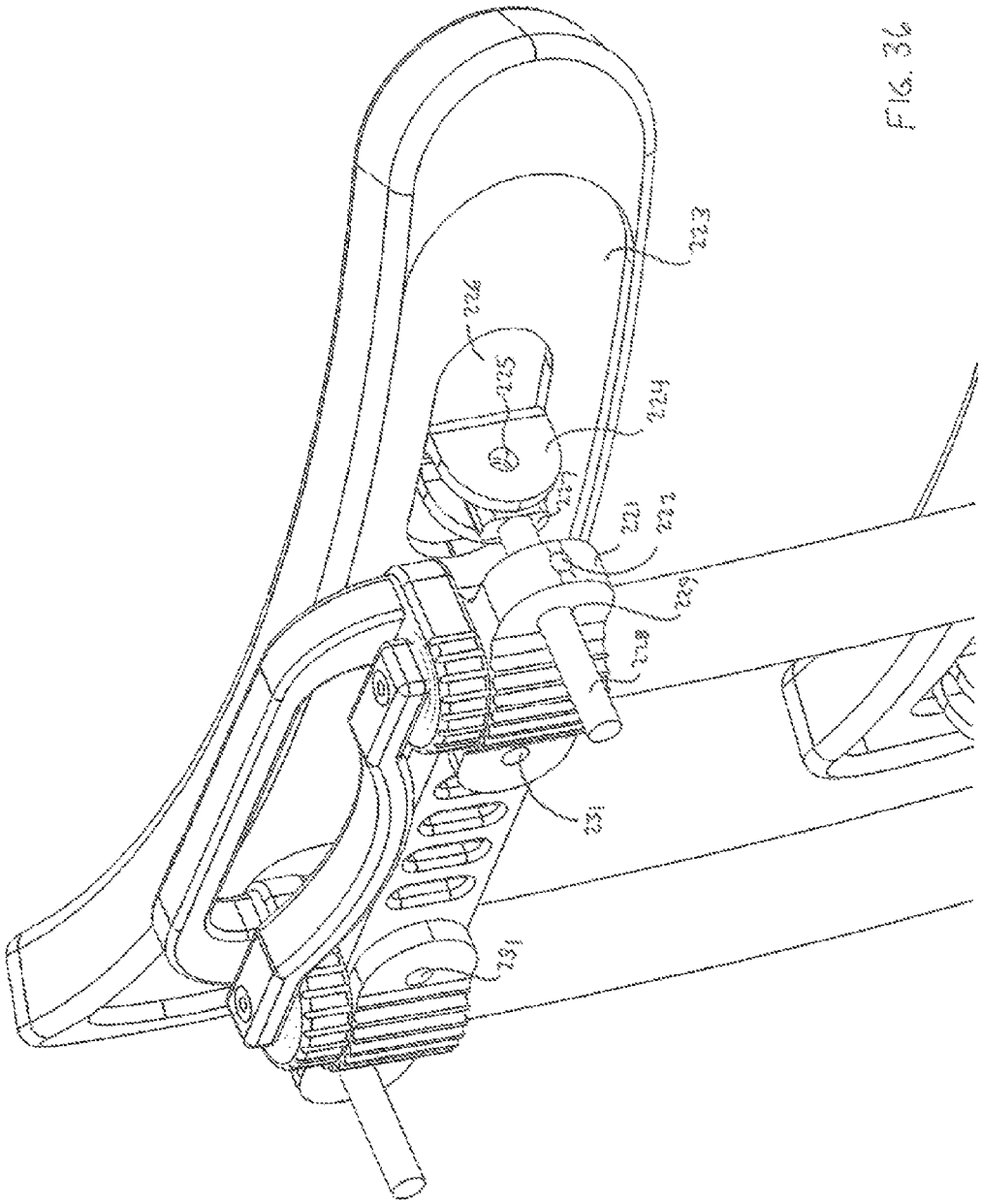

FIG. 36

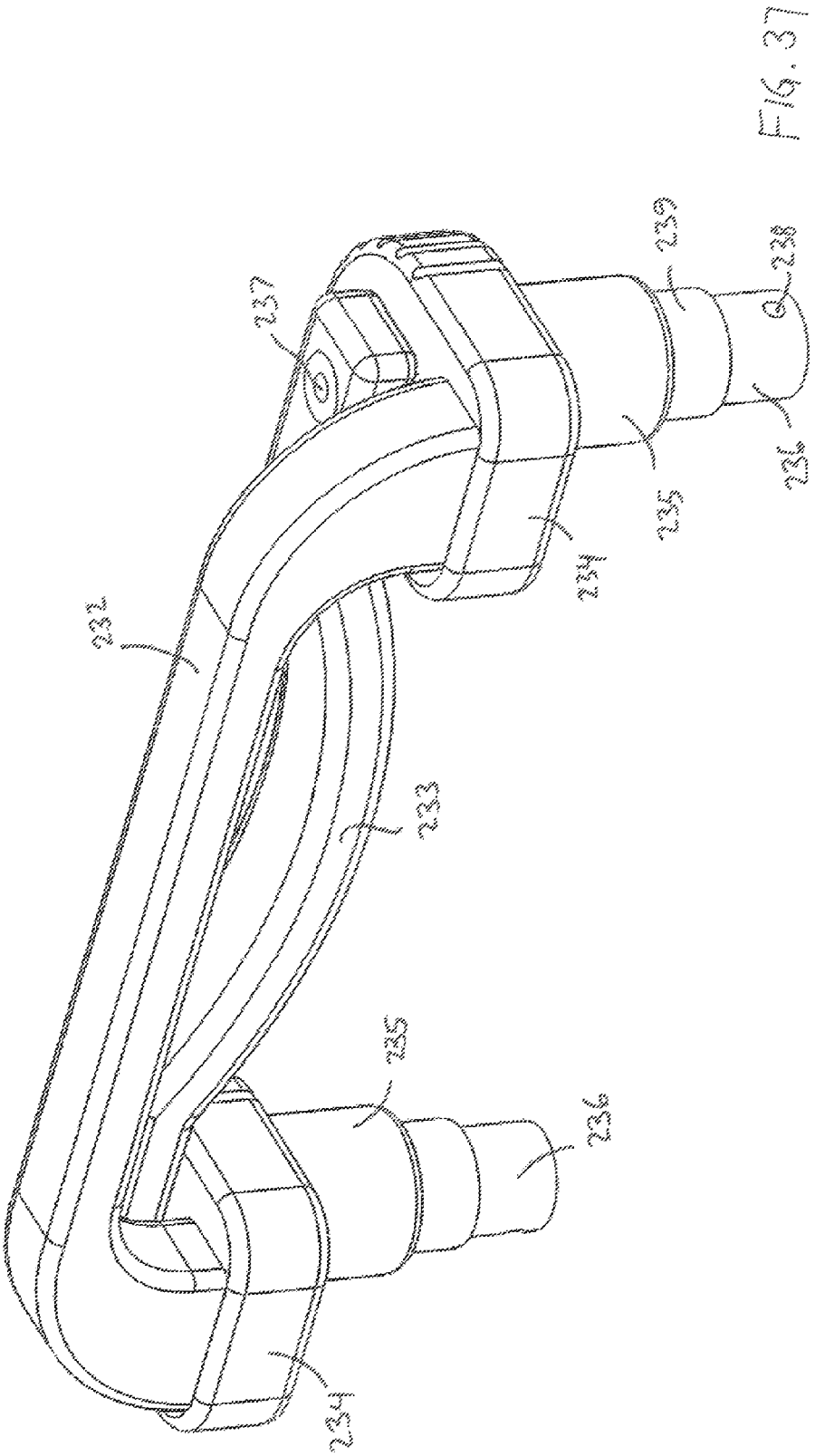

FIG. 37

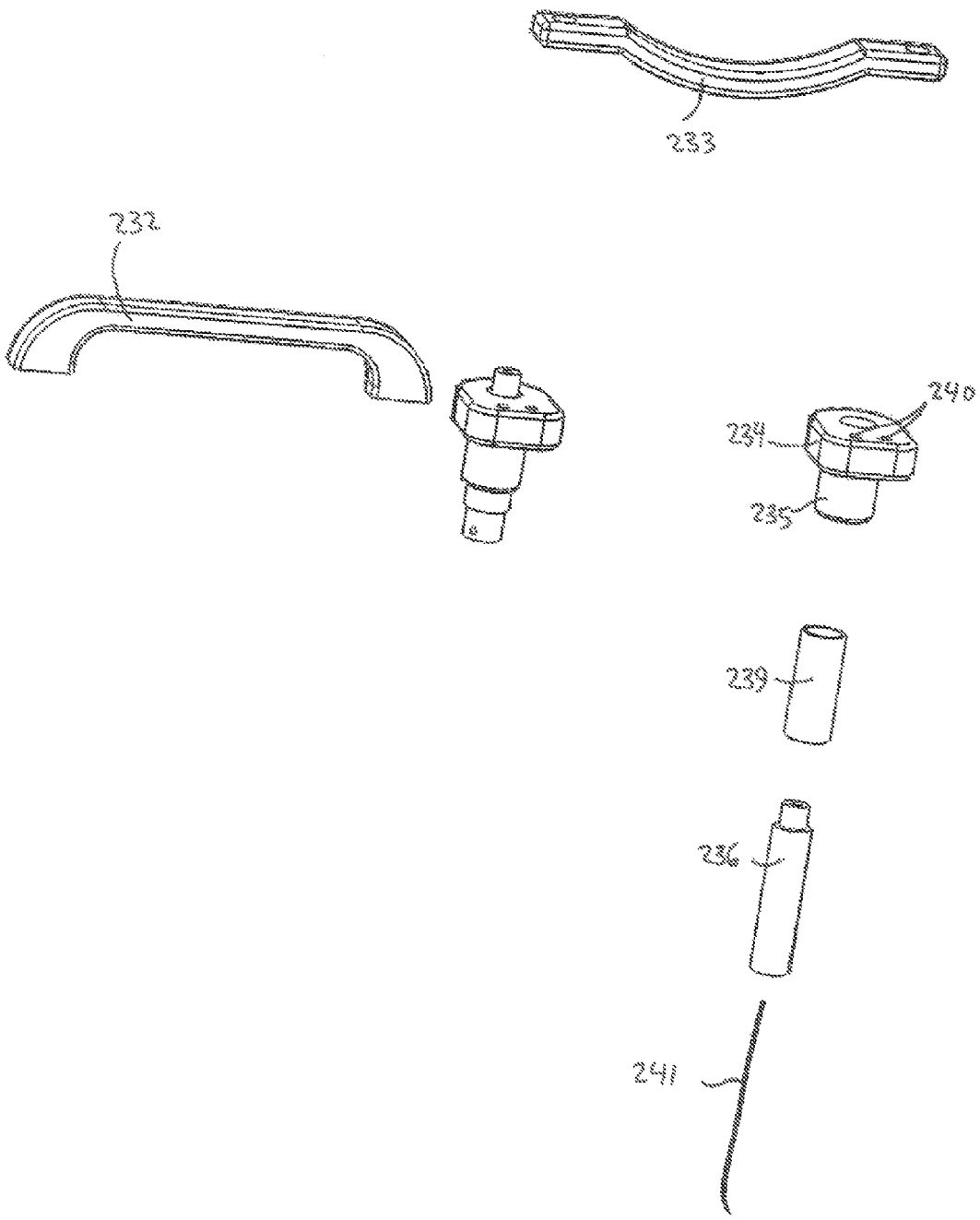

FIG. 38

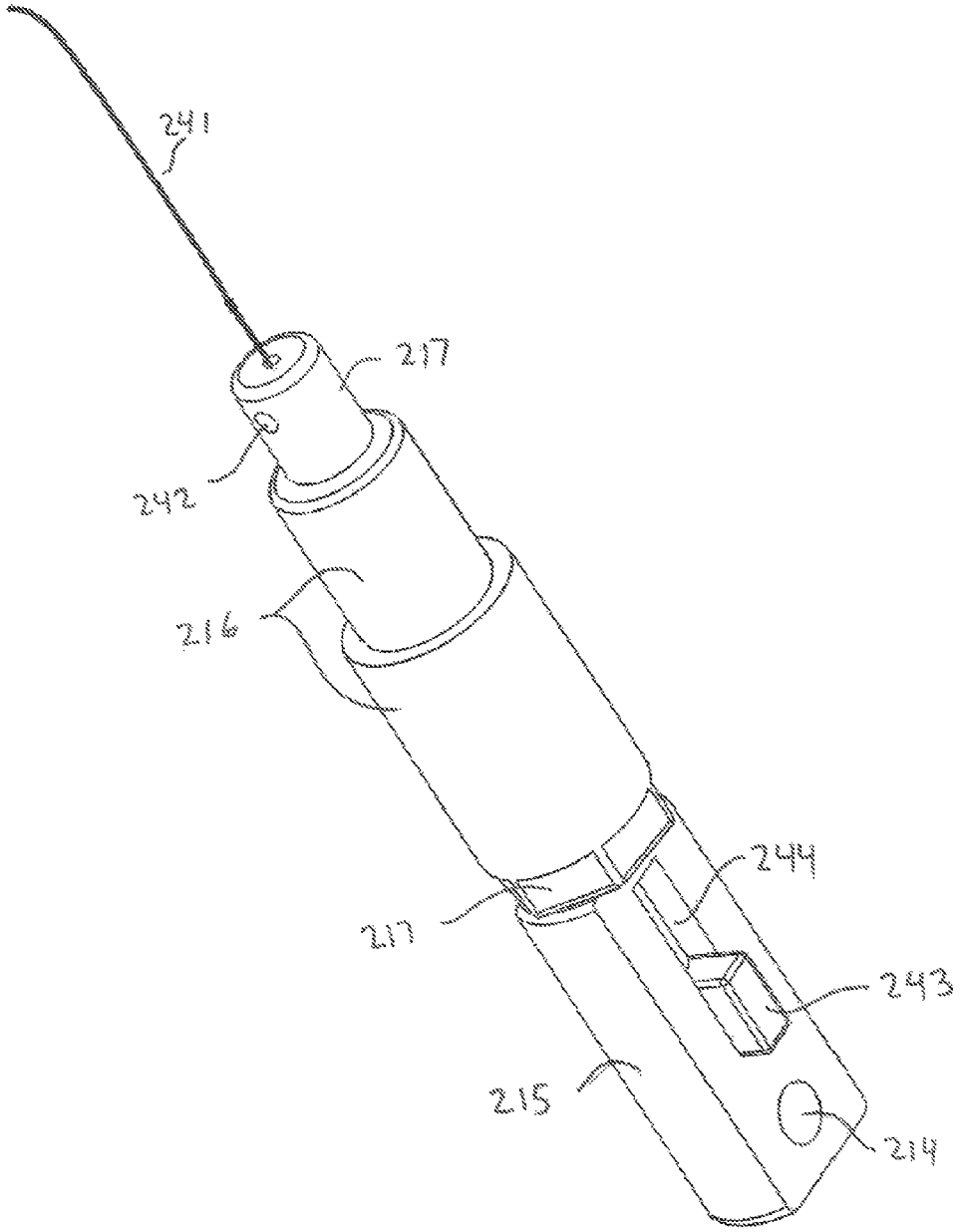

FIG. 39

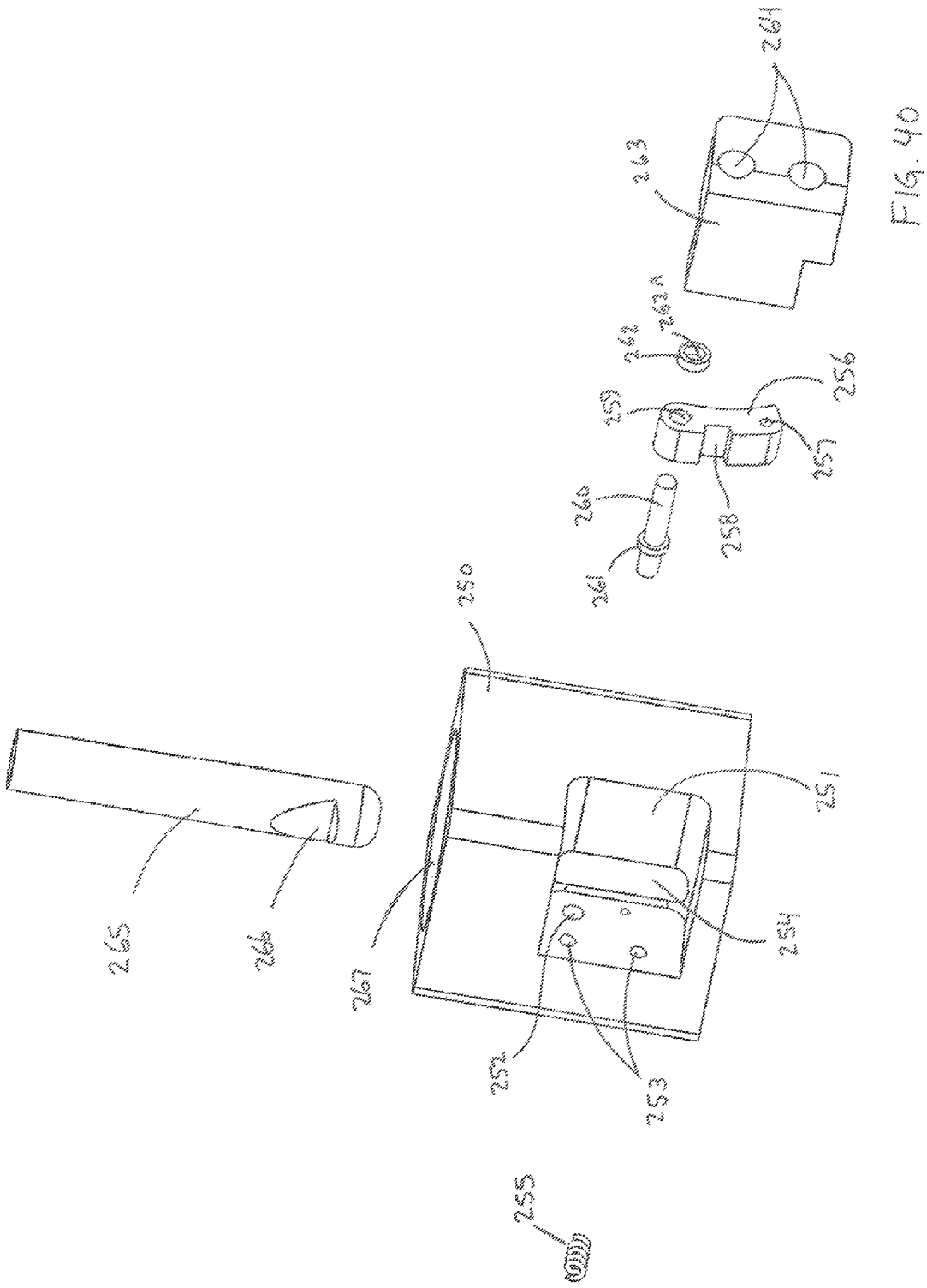
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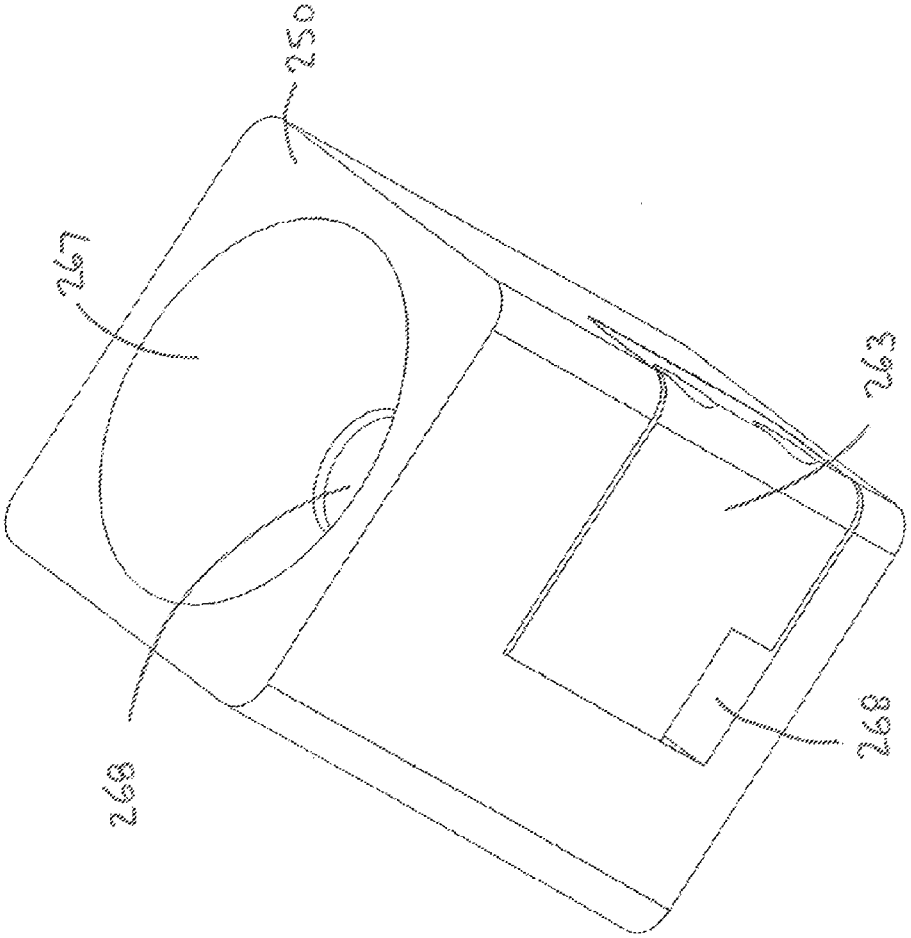
FIG. 40

FIG. 31



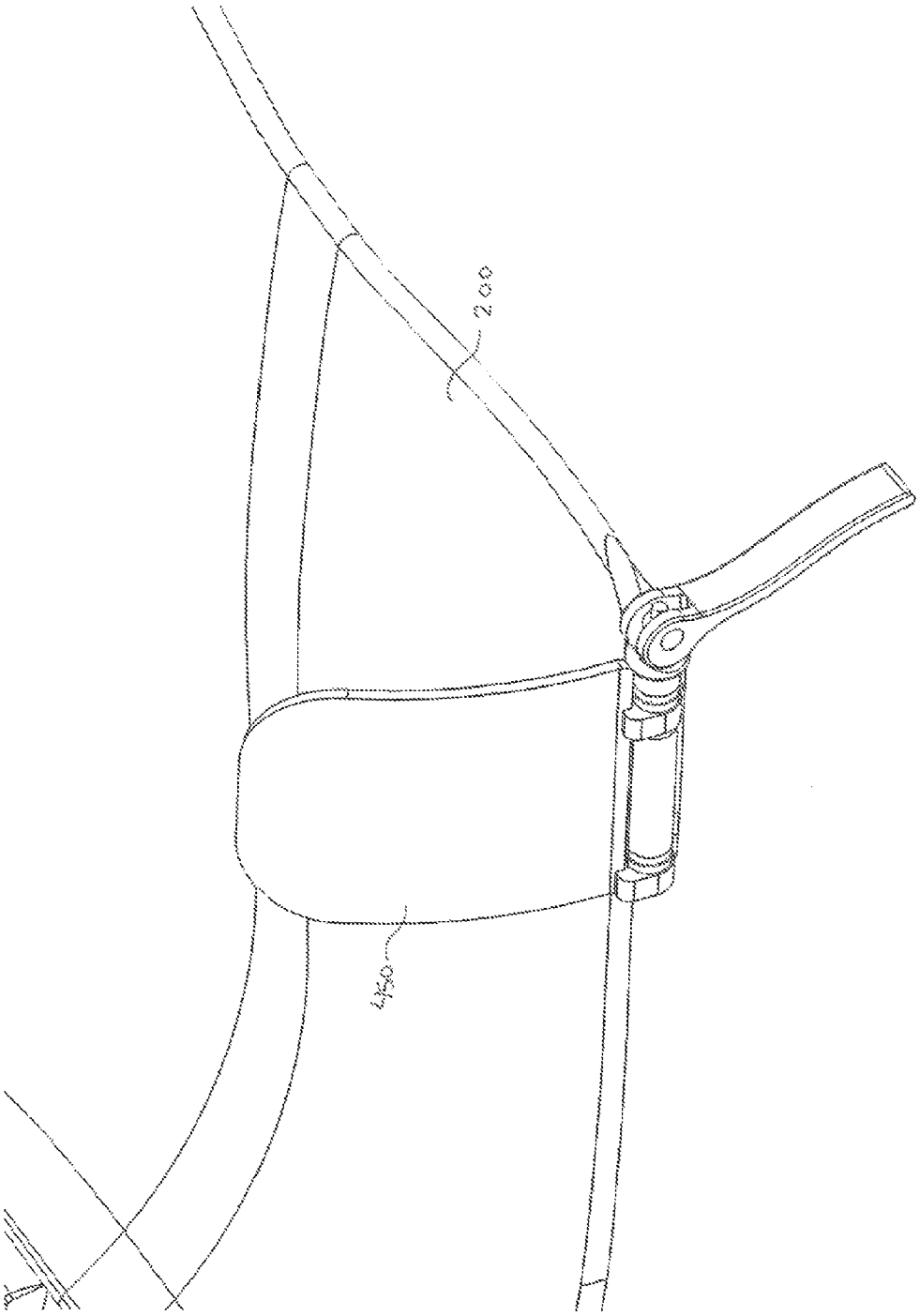


FIG. 42

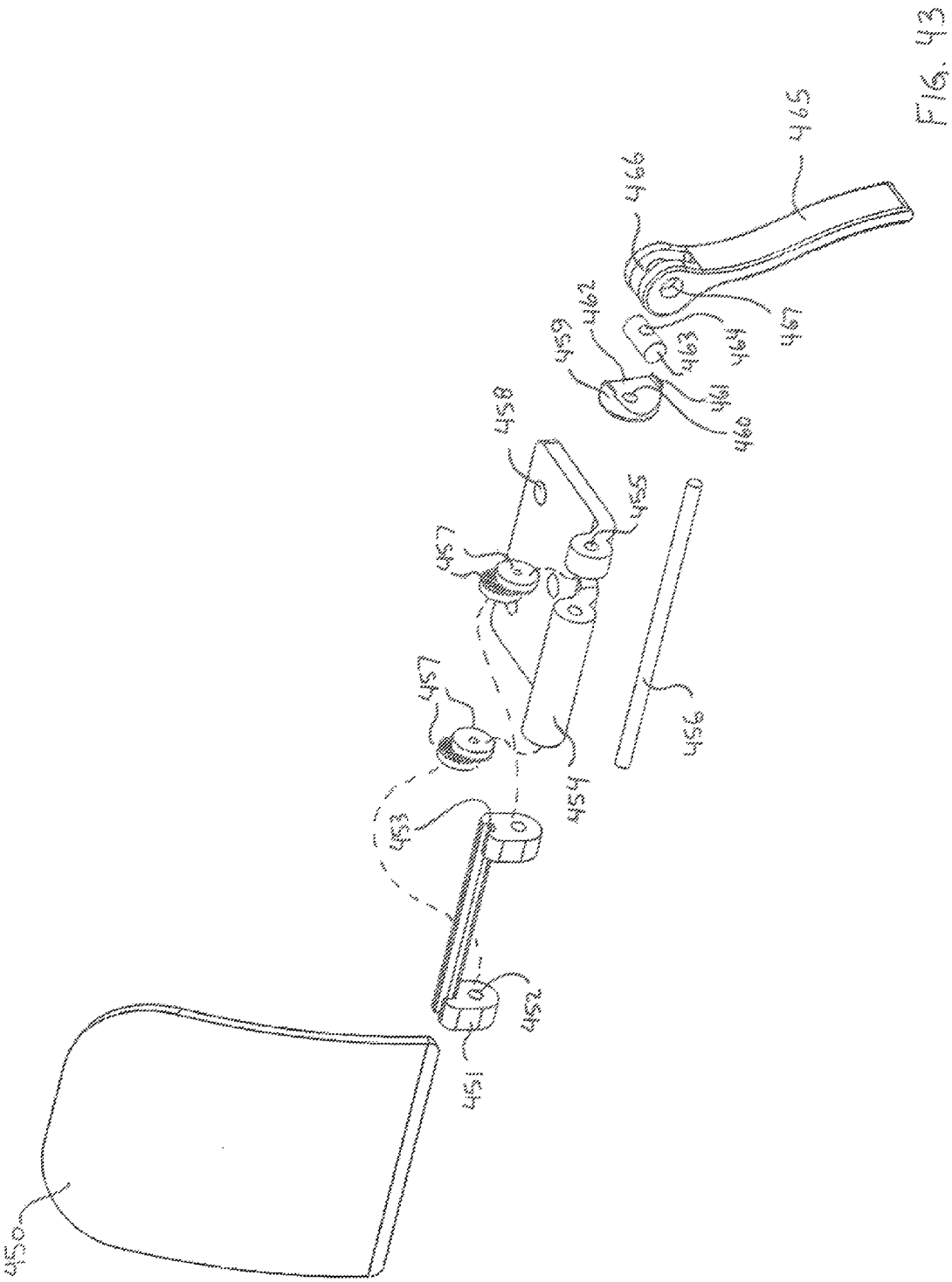


FIG. 43

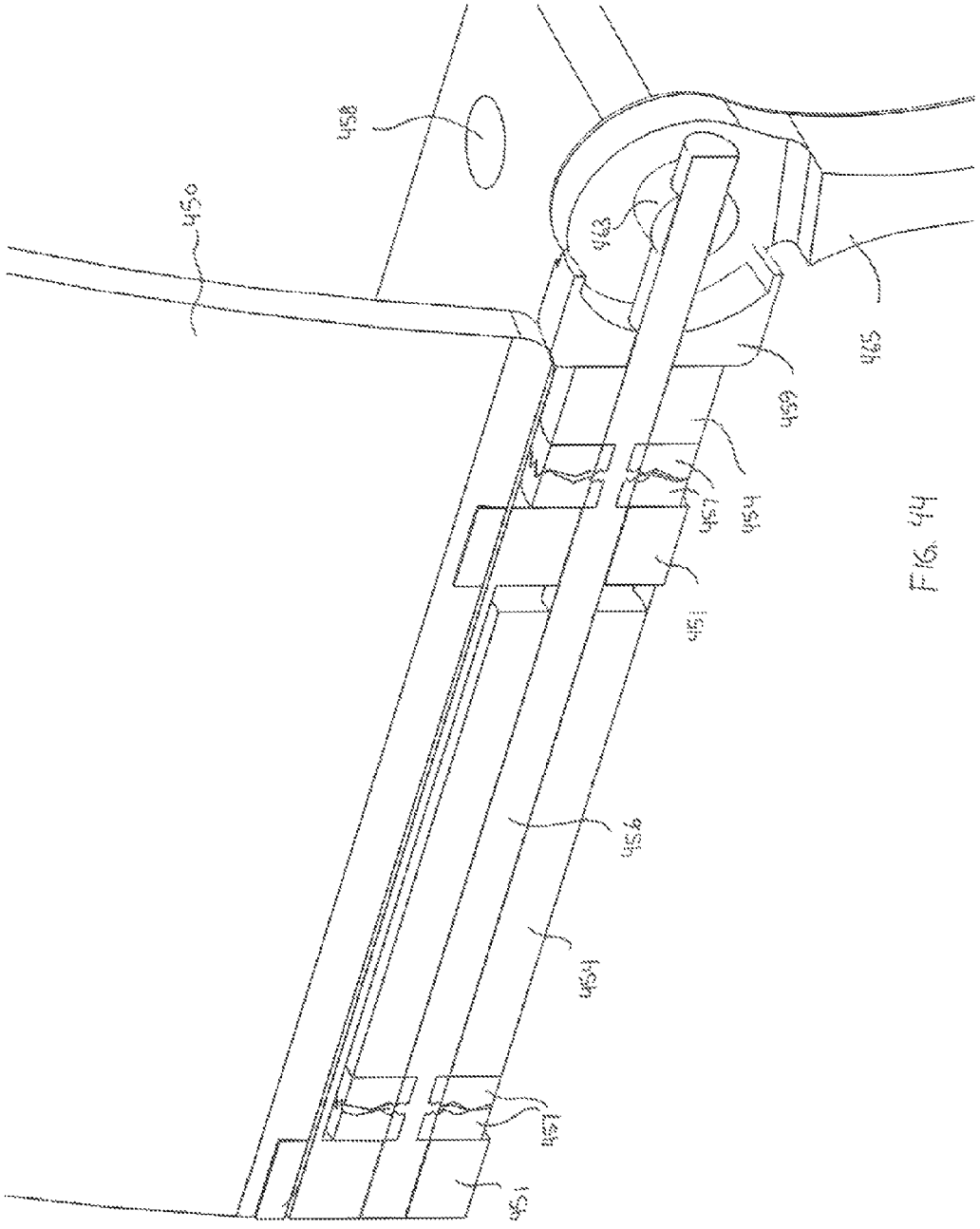


FIG. 44

DRIVE SYSTEM FOR A WHEELCHAIR

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation application of U.S. Ser. No. 14/261,343 filed Apr. 24, 2014, which is a continuation of U.S. Ser. No. 14/151,631 filed Jan. 9, 2014, a continuation of U.S. Ser. No. 14/029,138 filed Sep. 17, 2013, a continuation of U.S. Ser. No. 13/134,888 filed Jun. 20, 2011, a continuation in part of U.S. Ser. No. 12/315,548 filed Dec. 4, 2008, which claims the benefit of Provisional Patent Application No. 61/005,439 filed Dec. 5, 2007, Provisional Patent Application No. 61/005,446 filed Dec. 5, 2007, and Provisional Patent Application No. 61/005,447 filed Dec. 5, 2007.

FIELD AND BACKGROUND OF THE INVENTION

This invention relates to a wheelchair. Particularly, the invention is for a wheelchair which is propelled by means of a drive mechanism, the drive mechanism including a pair of reciprocating arm levers connected through a drive train to the rear wheels of the wheelchair.

SUMMARY OF THE INVENTION

According to one aspect of the invention, there is provided a wheelchair comprising: a frame or chassis; a seat mounted on the chassis; a front wheel assembly mounted on the chassis; a pair of rear wheels mounted on the chassis; and a drive train assembly for propelling the wheelchair in a selectively forward or reverse direction, the drive train assembly comprising an arm lever which can be moved back and forth by the user, a drive member connected to the arm lever by means of a chain, and a rear wheel hub assembly connected to the drive member by means of a chain.

The frame or chassis may be generally constructed of a plurality of block pieces connected to each other by a plurality of tubes.

In one embodiment, the seat comprises a base, a seating surface, and a back member, the back member being pivotable relative to the base so as to facilitate folding and storage thereof. The back member may comprise a pair of adjustable pads whose position and orientation can be adjusted to suit the physical requirements of the user. In one form, a circular lock slot may be positioned between the base and the back, the lock slot being adjustable between the folded and unfolded position, and a lock stop operation member at the top of the back member.

Preferably, the front wheel assembly is pivotable relative to the frame or chassis so that it is movable between a folded position for storage and transportation and an unfolded position for use of the wheelchair. The front wheel assembly may comprise a frame member, a foot support, a pair of castor modules, and wheels attachable to the castor modules.

In one embodiment, the arm lever has a lower portion connected to the chassis, a sprocket at or near the lower portion, and an upper portion which extends above the level of the seat so as to be conveniently located for gripping by the user. The arm lever may further comprise an inwardly directed handle at its end remote from the sprocket, and cables extending within the arm lever from the handle to the hub assembly. Preferably, the handles comprise rotatable gear changers, rotation of which acts on the cables to change gears formed in the wheel hub assembly.

In one embodiment, the rear wheel hub comprises a forward ramp ring and reverse ramp ring, and an inner clutch for selective operative engagement with either the forward ramp ring or the reverse ramp ring. An inner clutch slider may be provided upon which the inner clutch is mounted, the inner clutch slider having a slot therein for receiving a shift pull post, the shift pull post being axially movable by operation of a cable to shift the inner clutch slider within the rear wheel hub. Furthermore, a cable may extend between the shift pull post and the arm lever such that a user by maneuvering the arm lever is able to vary the tension in the cable to move the inner clutch slider and the inner clutch so as to selectively rotate each of the rear wheels in either a forward or rearward direction.

In a further embodiment, the rear wheel hub has associated therewith a sprocket which is connected by means of a chain to the drive member. The drive member may have a first sprocket and a second sprocket which connects by means of a chain to the sprocket on the arm lever, and a second sprocket which connects to the sprocket on the wheel hub by means of a chain.

Preferably, the drive member comprises a torsion mechanism having a torsion housing, a pair of sprockets at each end of the torsion housing, the torsion housing being rotatably mounted on a torsion shaft, the pair of sprockets at each end of the torsion housing being respectively connected to the arm lever and the rear hub respectively.

In one form, each of the rear wheels comprises a pair of wheel plates, the wheel plates being connected to the rear wheel hub assembly. The wheel plates may be substantially flat disk shaped structures which are spaced at an inner portion thereof at the connection to the rear wheel hub assembly and taper towards each other and are connected at an outer portion thereof where the tire mounts.

Preferably, the wheelchair further comprises a braking mechanism. The braking mechanism comprises a disk connected to the rear wheel hub assembly and a caliper attached to the swing arm and containing brake pads for selectively engaging the disk, the brake pads being operated by a brake engagement lever.

Furthermore, the seat may comprise a base, a seating surface and a back member, the seating surface being ergonomically configured for the comfort of the user. Each of the front wheels may comprise a pair of wheels.

In yet a further embodiment, the wheelchair comprises a pair of bolsters for supporting the legs of the user, each bolster comprising a plate like structure movable between a first position in which the legs of the user are supported and contained and a second position in which each bolster is moved to a non-operational position so as to be out of the way to facilitate the user in mounting or dismounting the wheelchair.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. **1** is a top perspective view of a wheelchair in accordance with one aspect of the invention;

FIG. **2** is a bottom perspective view of a wheelchair in accordance with the invention;

FIG. **3** is a side view detail of the drive and torsion mechanism of the invention;

FIG. **4** is a perspective view of the hub and other components, and the brake disk of a wheelchair of the invention;

FIG. **5** is a perspective cross-sections through a gear hub in accordance with one aspect of the invention;

FIG. **6** is an exploded view showing various components and fittings of the gear and hub of the invention;

FIG. **7** is a perspective view of a gear and hub in accordance with the invention;

FIG. **8** is a perspective view showing a rear wheel, hub, and other components, as well as a part of the frame;

FIG. **9** is a cross-section through the rear wheel and hub and showing the gear mechanism;

FIG. **10** is a further cross-sectional perspective view of the rear wheel and hub of the type shown in FIG. **9** of the drawings;

FIG. **11** shows a detail of the frame, arm lever, drive train and torsion bar of the invention;

FIG. **12** is a perspective view of a shaft collar and torsion bar which may be used in accordance with the invention;

FIG. **13** is a cross-section through the shaft collar as illustrated in FIG. **12** of the drawings;

FIG. **14** is an exploded view showing the various parts and components which make up the shaft collar and torsion bar in accordance with the invention;

FIG. **15** is a detail view showing the shaft collar in relation to the frame and rear wheel;

FIG. **16** is a detail of the shaft, torsion bar, swing arm and folding joint area of the invention including a cover;

FIG. **17** is a further detail view of the arm lever, frame, drive and other components in accordance with the invention;

FIG. **18** is a perspective view of an arm lever of a wheelchair in accordance with the invention;

FIG. **19** is an exploded view of the upper portion of the arm lever showing some of the internal components;

FIG. **20** is a detail view showing the arm lever shaft and support area;

FIG. **21** is an exploded detail view of the arm lever pivot joint to facilitate folding of the handle on the arm lever;

FIG. **22** is a cross-section detail showing the pivot joint Of FIG. **21** of the drawings, in the unlocked position;

FIG. **23** is a cross-section detail showing the pivot joint of FIG. **21** of the drawings, in the locked position;

FIG. **24** is an exploded view of a part of the arm lever and the pivot joint;

FIG. **25** is a detail of the lever arm at the pivot joint illustrating the space;

FIG. **26** is a top perspective view of the front wheel assembly and platform of a wheelchair in accordance with one aspect of the invention;

FIG. **27** is a bottom perspective view of the front wheel assembly and platform;

FIG. **28** is a detail view of a pair of front wheels and suspension mechanism;

FIG. **29** is an exploded view of a front wheel assembly and suspension mechanism;

FIG. **30** shows a detail exploded view of the folding joint and part of the frame of a wheelchair in accordance with the invention;

FIG. **31** is a split view of the folding joint as shown in FIG. **30** of the drawings;

FIG. **32** is a detail perspective view of the folding joint when in the folded position;

FIG. **33** is a perspective detail showing the wheelchair with the front wheel assembly in the folded position;

FIG. **34** is a perspective view of a seat for use on a wheelchair in accordance with the invention;

FIG. **35** is an exploded view of the seat showing the various parts and components thereof;

FIG. **36** is a detail view showing the back of the seat and the various mechanisms for adjustment thereof;

FIG. **37** is a perspective view of the parts and components relating to the seat to facilitate the unfolded and folded position of the seat;

FIG. **38** is an exploded view of the parts and components relating to the seat to facilitate the unfolded and folded position thereof as illustrated in FIG. **37**;

FIG. **39** is a perspective view of the seat back lower unlock handle system of a wheelchair of the invention;

FIG. **40** is an exploded perspective view of the seat lock mechanism for attaching the seat to the frame structure;

FIG. **41** is a detail of a component as illustrated in FIG. **40** of the drawings;

FIG. **42** is a front view of a seat bolster for use with a wheelchair in accordance with the invention;

FIG. **43** is an exploded view of the seat bolster as illustrated in FIG. **42** of the drawings; and

FIG. **44** is a split view of the seat bolster of the invention.

DESCRIPTION OF THE INVENTION AND DRAWINGS

With reference to the drawings, there is generally shown a wheelchair **10** (see FIGS. **1** and **2**, and others) of the invention comprising a number of interrelated and cooperating parts and components. Generally, the wheelchair **10** comprises a chassis **12**, upon which is mounted a seat **14**. Also mounted on the chassis **12** is a front wheel assembly **16**, which may comprise one or two wheels.

A pair of rear wheels **18** are mounted on the chassis **12**, one on each side thereof. The wheels **18** are selectively driven by the user of the wheelchair **10** by means of back-and-forth movement of arm levers **22**, having a grip or handle at one end for holding by the user, and a sprocket at the other end. This sprocket is connectable to a torsion mechanism **24** by means of a chain, and the torsion mechanism **24** in turn connects to a hub and gears **30** in the rear wheel **18**. By selectively operating the gears which are within the hub **30** of the rear wheel **18**, as will be described below, the user of the wheelchair **10** can cause each of the rear wheels of the wheelchair **10** to be propelled in either a forward or reverse direction, or to turn the wheelchair, as the situation dictates.

The above represents an overall description of the essential components, and the description below, in conjunction with the numerous figures and illustrations, disclose details relating to each of these components, as well as their relationship and interaction.

Hub/Clutch

Reference is now made to FIGS. **4**, **5**, **6**, **7**, **8**, **9**, **10** and others of the drawings which show details relating to the structure and function of the rear wheel hub **30**, including the clutch and gear change assembly housed therein.

The hub **30** of the rear wheel **18** is comprised of a housing which is formed by a clutch end cap **100** on the shift side, and a clutch end cap **104** on the sprocket side. The clutch sprocket **106** can be observed adjacent the clutch end cap **104**. Ramp rings **101** and **102** are located between the clutch end caps **100** and **104**. Each of the ramp rings **101** and **102** have pawl arm ramps **136**. The pawl arm ramps **136** formed on the ramp rings **101** and **102** have different or opposing directions. When the pawl arm ramps **136** on the ramp ring **102** are engaged with the pawl arms **122**, as will be described below, the wheelchair **10** will be propelled in a forward direction. Conversely, when the pawl arm ramps **136** on the ramp ring **101** are engaged, also to be described below, the wheelchair **10** will be propelled in a reverse direction.

A rear wheel collar **103** is attached to the ramp ring **101**, and a ramp ring collar **105** is provided outside and adjacent

the clutch end cap **104**. The rear wheel collar **103** and the ramp ring collar **105** will be attached to the rear wheel **18**, as will be seen in other figures. The clutch sprocket **106** is mounted on a clutch sprocket mounting sleeve **107**.

An axle **108** extends through the hub, including the clutch end caps **100** and **104**, the ramp rings **101** and **102**, as well as the clutch sprocket mounting sleeve **107** and clutch sprocket **106**. Case bearings **118** and **119** are formed at each end of the hub in the clutch end caps **104** and **100** respectively. The axle **108** is held by and extends through these case bearings **118** and **119**, and is attached to the swing arm with fastening means utilizing the external threads at both ends.

Within the hub, there is an inner clutch slider **120**, including an internal slot **139** therein, the slot **139** receiving a shift pull post **113**. Appropriate maneuvering of a cable **145**, to be described, allows the shift pull post **113** to move axially within an axle slot **109** formed in the axle **108**, and the position of the shift pull post **113** within the internal slot **139** causes movement of the inner clutch slider **120**, causing hardware, as will be described, to move within the hub to allow selective engagement of either the ramp ring **101** or **102**, which results in the forward or reverse direction propulsion of the wheelchair, as mentioned above.

The inner clutch slider **120** includes a shoulder **144**, and a pair of inner clutches **121** formed on the inner clutch slider **120**. The inner clutches **121** includes three pawl arms **122** per inner clutch which engages the pawl arm ramps **136** in the ramp rings **101** and **102** respectively. The axial movement of the inner clutch slider **120**, as operated by the user, causes axial movement of the inner clutch **121**, thereby selectively engaging the pawl arm ramps **136** in ramp ring **101** and **102** respectively so as to effect forward or reverse motion of the wheelchair.

The axle **108** holds an axle sleeve **141**. The axle **108** has an axle through hole **138**. Further, the axle **108** comprises an axle flange stop **110** and axle flange shoulder **111**. The previously referenced axle slot **109**, through which the shift pull post **113** radially projects, is able to move axially within the axle slot **109**, extend into the internal slot **139** of the inner clutch slider **120**, and effect change of direction of movement of the chair. A shift shaft **112** is located and slides within the axle through hole **138**, and the shift pull post **113** threadedly attaches to the shift shaft **112** as shown. A shift spring **114** is provided to provide the biassing force on the shift shaft **112**, and is held in position by a spring retainer block **115**.

The shift shaft **112** and shift spring **114** are housed within the axle through hole **138** of the axle **108**. The shift pull post **113** extends outwardly through the axle slot **109**. A pair of clutch axle bushings **117** are provided, and an axle stop bushing **116** is provided between the axle flange stop **110** and one of the clutch axle bushings **117**. The axle sleeve **141** is then mounted over the clutch axle bushings **117** on the axle **108**.

The inner clutch slider **120** is then mounted over the axle sleeve **141**, and positioned such that the shift pull post **113** is received within the internal slot **139**. The case bearing **119** is positioned over the axle **108**, and the axle bearing **118** is positioned over the axle sleeve **141**, and the axle **108** passes therethrough. The hub with its various components as described above, and to which is attached to one of the rear wheels **18** of the wheelchair **10**, is capable of rotating about the axle **108**.

The inner slider clutch **120** comprises two inner clutches **121**, each of which has three pawl arms **122** mounted by means of a pawl post **122***a*. One inner clutch **121** has pawl arms **122** which engage with the pawl arm ramps **136** on the ramp ring **101**, while the other inner clutch **121** has pawl arms **122** which engage with the pawl arm ramps **136** on the ramp ring **102**. These ramp rings **101** and **102** effect respectively forward or reverse direction of movement of the wheelchair when the arm levers are moved. The pawl arms are kept in tension by a collar spring. Only one of the inner clutches **121** will be in contact with pawl arm ramps **136** on the ramp rings **101** or **102** at any one time. The axial sliding of the inner clutch slider **120** between its first and second positions, corresponding to forward and reverse motion of the wheelchair, will cause either selective engagement with one such pawl arm ramp **136** or the other. The inner clutch **121** not driving a ramp ring **101** or **102** will be idle in the sense that it does not have any active driving capacity at this point. For an example of this, please see the figures which show the inner clutch **121** in contact with the ramp ring **102**, but not with the ramp ring **101**.

By means of an adjustable cable which forms part of the arm lever, and which will be described further below, the user of the wheelchair **10** causes the inner clutch slider **120** to move axially over the axle sleeve **141** and around the axle **108**. This is achieved by the axial movement of the shift pull post **113** engaging in the internal slot **139** of the inner clutch slider **120** and moving it so that an inner clutch **121** on the inner clutch slider **120** selectively engages the pawl arm ramps either on the ramp ring **101** or the ramp ring **102**. Since these respective ramp rings **101** and **102** have oppositely directed pawl arm ramps **136**, the movement of the arm lever will have opposite effects depending upon whether the inner clutch slider **120** is engaged with either one of these ramp rings **101** or **102**. Therefore, forward or reverse motion of the wheelchair can be achieved by operation of the cable and the selective positioning of the inner clutch slider **120** according to the direction of movement designed by the user.

Rear Wheel Arrangement

Reference is now made to the FIGS. **8**, **9**, **10**, **11**, **12**, **13**, **14**, **15**, **16**, **17**, and others, which show the attachment of the rear wheel **18** to the gear and hub assembly **30**. These figures show the wheel plates **400**, and inner and outer plates fastened together around the perimeter via bolts **405** through holes **404**, and also connected to the hub **30** via bolts **406** though holes **403** in the rear wheel collar **103** and ramp ring plate **105**, thus connecting the wheel plates together and to the hub **30**.

Also shown is the wheel tire **401**, and a fender **402** which may be positioned thereover. The wheel and hub assembly is connected by means of a pair of swing arms **510**, including an inner swing arm and an outer swing arm respectively on the inside and the outside of the wheel and hub assembly via fasteners through the wheel collar mounting holes **124** into mounting holes **125** as well as via fasteners through small ramp ring plate mounting holes **130** into clutch end cap mounting holes **128**. As will be appreciated, the hub **30** contains the hardware mechanisms for driving the wheel, shifting gears, and achieving forward and reverse movement.

Also shown in these figures is a braking system including a disk and caliper arrangement, to be described further below.

Drive Train and Torsion Mechanism

The drive train torsion mechanism of the wheelchair propagation system will now be described, as illustrated in FIGS. **3**, **8**, **11**, **12**, **13**, **14**, **15**, **16**, **17**, and others. The torsion mechanism **24**, as will be appreciated from previous description, comprises an intermediate structure between the clutch hub arrangement within the rear wheel **18**, as already described, and the arm lever **22**, particularly the sprocket thereof, of the wheelchair **10**. The torsion mechanism is thus connected to both the sprocket of the arm lever, on the one hand, and the clutch hub mechanism in the rear wheel, on the other, thereby facilitating the back-and-forth motion of the arm lever into

driving energy for rotating the rear wheel **18**, in either the forward or reverse direction, through the hub clutch mechanism.

The torsion mechanism **24** comprises a torsion shaft **500** including a threaded through hole **504** and a splined end **528**. A torsion shaft bearing shoulder **515** surrounds a part of the torsion shaft **500**. A torsion outer housing **501** is provided, and includes a shoulder **506** on each side, and a series of slots **502** associated therewith upon which a sprocket **511** is received at mounted. The sprocket **511** has an opening **514** which fits over the end of the torsion outer housing **501**, and one or a series of sprocket mounting tabs **513** projecting into the opening **514** engage with corresponding or registering slots **502** on the torsion outer housing **501**.

A pair of bearings **505** fit over the torsion shaft **500** and support the torsion outer housing **501**.

Threaded end nuts are provided to secure the sprockets **511** onto the torsion bar outer housing **501**, and these threadedly engage with correspondingly threaded ends of the torsion outer housing **501**.

The torsion shaft **500** is received in and connected to the chassis portion of the wheelchair **10**, and is mounted within an outer main support **625** and an inner main support **626**, which are joined together by support tubes **628**. The torsion shaft **500** is supported within the outer main support **625** by means of a torsion bar bearing **633** and the splined end **528** is received within the fixed splined module **525**. The end of the torsion shaft **500** opposite that to the splined end **528** is received within the swing arm **510**, the other end of the swing arm **510** being connected to the axle of the rear wheel hub mechanism located in the center of the rear wheel **18**.

The torsion shaft **500** itself allows the rear wheel to have movement up and down much as cars have suspension. The torsion shaft **500** is mounted firmly at one end with splines **528** interlocked with splines **527** set inside a fixed module **525** and supported by bearings **633**. The swing arm **510** is fixed to the shaft **500** and utilizes its length to incur "twist" in the shaft **500**. The shaft **500** is preferably of a material that constantly returns to its original state and allows for the swing arm **510** and the rear wheel **18** to move fluidly as the wheelchair **10** may traverse terrain which may not be smooth.

Located about the shaft **500** is a torsion outer housing **501** which is free to spend in either direction and allows the arm lever motion to be transferred via chains and sprockets from an inboard line of motion to a more outboard line of motion, or transferred across the outer housing **501** which is rotating on bearings **505**, and supported by the torsion shaft **500**. In this way, the torsion shaft **500** is supporting two different actions, namely, motivation and suspension.

An arm lever **553** having a lower end is connected to an arm lever shaft **550**. The arm lever shaft **550** is supported by the arm shaft block **555**. The arm sprocket **551** is mounted over the arm lever shaft **550**, and has a plurality of teeth **552**. The arm sprocket **551** is connected by a chain to the first sprocket **511** on one side of the torsion outer housing **501**. The sprocket **511** on the other side of the torsion outer housing **501** is connected by a chain to the clutch sprocket **106**, details of which have been described above.

Arm Lever

As will be seen from the drawings, including FIGS. **1**, **2**, **11**, **16**, **17**, **18**, **19**, **20**, and others, the arm lever **553** extends upwardly from its mounted position on the arm level shaft **550**, and includes an access cover **558** around the main push handle body **557**. A push handle **565** extends transversely outwardly from the arm lever **553** so that it is inwardly directed with respect to the wheelchair **10** so as to provide easy access to the push handles **565** by the user. At the end of the push handle **565** there is formed a gear shift knob **566** which can be rotated by the user to change which inner clutch and pawl arms engage in the hub portion in the rear wheels, so that appropriate selection can be made to the forward and reverse motion of the wheelchair. Details as to how this may be achieved have already been described in detail above with reference to other figures and drawings.

Internal cable rollers **559** and **560** are provided, and rotation of the gear shift knob **566** alternatively tensions or slackens the cable which extend from the internal cable roller. This cable extends through a shift cable alignment groove **571**, and extend through the arm lever **553** and are appropriately directed to the gear and hub mounted in the wheel of the wheelchair. The rotation of the gear shift knob **566** therefore achieves, through the presence of the cables, the ability to effect movement of the inner clutch slider **120** to change gears, as described, to selectively achieve forward or reverse motion.

Handle Structure and Operation

Reference is now made to FIGS. **18**, **21**, **22**, **23**, **24**, **25**, and others, showing the handle structure and operation. This is one embodiment, and other versions or variations of this arrangement will also fall within the scope of the invention. The handle is positioned on the arm lever **553** for operation by the user, preferably extending inwardly from the arm lever **553**, and positioned in a convenient location for the comfort and easy operation of the user.

The handle is comprised of a pivot joint block **530**, and internal slider **533**, and an internal fixed locator **537**. A spring **532** is positioned between the pivot joint block **530** and the internal slider **533** so as to urge the internal slider **533** away from the pivot joint block **530** in the normal course. The pivot joint block **530** comprises a lock mounting extrusion **531** and a spring floor **530**A which forms a base or shoulder for one end of the spring **532**.

The internal slider **533** is a generally cylindrical structure having a shoulder stop **534** at one end thereof, and axial lock grooves **535** extending down its length on the outer surface thereof. A through hole **536** is provided for receiving various cables extending between the handle and the gear assembly so that the user can select forward movement, reverse movement, or a neutral position. The shoulder stop **534** forms the other surface for receiving the spring **532**.

The internal fixed locator **537** comprises four substantially equispaced pivot lock engagement tabs **538**, each of the tabs **538** being received in a corresponding lock groove **535** on the internal slider **533**. In one operating configuration, the engagement tabs **538** are received within the lock grooves **535** formed in the shoulder stop **534**, thereby preventing rotation of the internal slider **533** in this position. The internal fixed locator **537** further comprises a through hole **539** for the cables, as referenced above, and threads **537**A on the outer circumferential surface thereof.

A push handle main body **557** and the access cover **558** thereof are attached to the internal fixed locator **537**, and the pivot joint block **530** attaches to the arm lever **553**. A space **533**B is provided, and is of a size which is sufficiently large so that the axial movement of the handle toward the arm lever has the effect of sliding the internal slider **533** so that the engagement tabs **538** of the internal fixed locator **537** become disengaged from the lock grooves **535** in the shoulder stop **534**. The axial movement of the internal slider **533** is against the bias of the spring **532**, so that the spring **532** would in the normal course urge engagement between the tabs **538** and grooves **535** when they are suitably aligned. However, when the tabs **538** and grooves **535** are disengaged and nonaligned, the handle can be rotated up to about 90 degrees relative to the

arm lever **553** allowing clearance when the chair is folded. In the folded position after a 90 degree rotation, the tabs **538** can re-engage in the grooves **535** to lock the handle in that configuration.

As mentioned above, the mechanism for rotating the handle as described above is just one of several which can be used in accordance with the invention, which is not limited to this specific configuration.

Front Wheel Assembly

The front wheel assembly **16**, as seen in FIGS. **1**, **2**, **28**, **29**, **30**, **31**, **32**, **33**, and others, is attached to the chassis **12** of the wheelchair **10** by means of a pair of forward down tubes **592**. The attachment of these forward down tubes **592** to the chassis **12** is achieved in such a way that the front wheel assembly **16** can be retracted, folded, under the chassis **12** so as to render the wheelchair in to a more compact and more easily transportable configuration. Further details relating to the mechanism for compacting or folding the front wheel assembly **16** will be provided below with reference to other figures.

Each of the forward down tubes **592** at their ends remote from the connection to the chassis **12** is attached to a caster module **355**. Extending inwardly and laterally from each caster module **355** is a frame joint **308**, attached to a substantially frame vertical tube **307**. A frame lower tube **306** connects each of the respective frame vertical tubes **307**, including frame joints **305** and a pair of frame pivot collars **304**.

A foot rest platform **300** is attached to the frame lower tube **306**, and includes foot rest vents **301**, ports **302**, a heel separator support **303**, a foot rest pivot tube **309**, and such other hardware that may be included for the users comfort and convenience.

Extending downwardly from each caster module **355** is a caster stem main body **362** which connects to the caster module **355** through a pair of caster module bearings **358** pressed into a caster module **355** at top and bottom openings. The caster stem main body **362** includes an upper caster stem **360**, having threads **361** for attachment through a securement of a caster module. The lower end of the caster stem main body has attached thereto a pair of front swing arms **366** mounted thereto by a pin or bolt extending through holes **367** and **365**. The front swing arms have apertures **368** therein for receiving the front axle **372**, which includes the front axle shoulder **373**. A pair of front wheels **353** each having their own front tire **354** is mounted on the front axle **372** at each end thereof, with appropriate additional hardware such as the front axle spacer **370**, front wheel bearing, and cap **377** to facilitate the connection. A spring **379** extends from the spring attachment notch **363** on the main stem body **362**, and the opposite end of the spring is received within the spring hole **369** on the front swing arms **366**.

As will be noted from the above construction, the attachment of the front wheels through the swing arm **366** and associated spring **379** provides a front suspension system for a smoother ride. The front wheels will be capable of some limited up and down rotational or pivotal movement, in response to encountered irregularities or bumps on the riding surface, against the bias of the spring **379**. The spring would return the wheels to their substantially normal position once the irregularity has been traversed.

The caster module **355** includes a headlight housing, which encloses the tip of the caster module **555**, and also contains a headlight port **326** and one or more headlights **327**.

Front Wheel and Foot Rest Folding Mechanism

As briefly alluded to above, the front wheels and frame assembly, as seen in FIGS. **1**, **2**, **26**, **27**, **28**, **29**, **30**, **31**, **32** and **33**, and others, may be folded underneath the seat and chassis in order to compact or fold the wheelchair to thereby make it more convenient for storage and transportation.

As shown in the figures, a pivot lock module **575** attaches between the outer main supports **625** and **626** of the right side chassis. The pivot lock module **575** includes a series of pin and spring recess holes **589** for receiving a series of pins **579**. Pivot axle bolt holes **581** and **582** are formed in the outer main supports **625** and **626**, and a pivot lock module pull post rod **578** extends from the pivot lock pull post hat **577**, passing through the pivot axle bolt hole **581**, the hole **591**, and finally through the hole **592**. An extension **588** connects to the forward down tube **592** which is the main support for the front wheel assembly. Rotating and pivoting the tube **592** would of course result in the rotation, pivoting and folding of the front wheel assembly.

A pull cable limiting cup **584** is mounted about the pull post rod **578**, and has a shoulder **585**, as well as an alignment shoulder **586**. A pin lock release module **576** is provided having push legs **587**, and these act on the pins to push them into disengagement from the pin lock holes **580**. When the pins are in the pin lock holes **580**, rotation of the down tube **592** will be prevented. By pulling on the pivot lock pull post hat **577** and rod **578**, the pins by the action from the springs will be pushed out of the pin lock holes **580**, allowing rotation and folding or unfolding of the down tube **592**. The down tube **592** can be rotated from completely open (the usable position) to completely closed (the stored position) positions only.

Seat Structure

The wheelchair **10** comprises a seat **14** for accommodating the user. See FIGS. **1**, **2**, **34**, **35**, **36**, **37**, **38**, **39**, **40** and **41** and others. The seat **14** is in many respects adjustable to suit the specific physical requirements of the user, so as to provide good comfort and positioning for propelling the wheelchair. Further, the seat **14** is configured with the arm lever so that the arm levers are in positions which may be best suited for grasping by the user and propelling the wheelchair. Further, the seat may include components and mechanisms which allow it to be folded and/or removed so as to make the wheelchair easier to store or transport by occupying a smaller footprint.

In one embodiment of the invention, there is shown a seat arrangement which includes a seat bottom **200** including a bolster mount pad **201**. An arrangement of lock seat joint **202**, including various openings **206** to make the seat lighter, are provided and the seat bottom **200** is appropriately mounted on the lock seat joint **202**. The structure may include mounting flat pads **204** for improved mounting and stability.

A pair of raiser arm pods **205** extend upwardly from the lock seat joint **202**. Each of the raiser arm pods **205** is connected to an upwardly extending steel tube **218** by means of a lower lock tube **215** and an upper lock tube **216**. The lower lock tube **215** connects to the raiser arm pods **205** through lock discs **208**, the lock discs **208** including axle mounting holes **211**, mounting holes **210**, as well as a pair of lock slots, one of the lock slots **209** being utilized when the seat is in the folded position and the other of the lock slot **209***a* be utilized when the seat is in the open or user position.

The pair of seat tubes **218** support a lower seat support pad **219** and an upper seat support pad **220**, which may be cushioned and are adjustably located on the seat tubes **218** to best meet the physical comforts and shape of the user's body. The adjustability of these seat support pads may not only allow the up-and-down movement thereof over the seat tubes **218**, but they may also be adjustable so that they can be moved backward and forward relative to the seat tubes **218** to meet the physical requirements of a specific user. They may also be

adjustable in degrees, such as 90°, 117°, 62°, etc. (90° being generally vertical to the ground) to further meet the individual user's physical requirements.

The seat structure further comprises a pair of support or bolster arms near the forward end of the seat bottom **200**. These arms are designed for helping to keep the legs of the user confined and stabilized on the seat bottom, and may be maneuverable between a myriad of positions, for example from about 90° straight up moving 45° toward the center of the seat with each degree change making the bolster to seat relationship smaller and thus tighter for more confinement of thinner legs of a user. In a further position, the arms may be folded away or downwardly directed when not is use so as to make user access to the seat of the wheelchair easier when getting into or out of the seat. This will be described in further detail in a separate section below.

At the top of the seat tubes **218**, there is formed an operating mechanism in contact with the other structure on the chair, and by means of which the seats may be tilted and folded around the lock disk, enabling the seat back to move between its extended user position and the folded storage and transportation position. A seat lock module **234** is provided at the top of each seat tube **218** and a seat lock module insert **235** is provided and connected to a pull rod **236**, which slides through **235** via bushing **239**. A brace handle **232** is formed on the seat lock module. Also provided is a pull handle **233**. The pull handle **233** can be pulled outwardly or upwardly, and the brace handle **232**, being in a fixed position, may be used as a counterforce and grip to facilitate the folding and unfolding operation of the seat back.

The pull handle **233** connects to the pull rod **236** in the seat tube **218**. The pull rod **236** attaches to an unlock cable **241**, which at its other end attaches to a lock pull rod **217**. This comprises an upper lock tube **216** and a lower lock cube **215**. The lower lock tube **215** includes a seat lock block **243** which moves up and down in response to the pulling on the cable **241** within a seat lock block slot **244**. When the seat lock block **243** is in its lower or normal rest position, it is able engage within one of the lock slots **209** or **209***a*. If the seat back has been tilted into its operating or unfolded position, the seat lock block **243** will be received within the lock slot **209***a*. This will fasten the lock discs to the seat joint arm pods **205**, and secure the seat back in the generally operational position. When it is designed to fold the seat back, the pull handle **233** is raised, and through the action of the various components including the cable, the seat lock block **243** will slide upwardly in the seat lock block slot **244**, and out of the lock slot **209***a*. The seat back is then free to rotate into the folded position, and when the folding has reached a sufficient degree, the lock slot block **243** will step into the lock slot **209** so as to keep the seat back in this folded position, until the user needs the wheelchair once more, and the seat back is unfolded by carrying out the generally reverse procedure described above.

A further figure of the seat release mechanism for unfolding and folding the seat back illustrates some of the additional components, including bushings and spread nuts.

In another embodiment, there is shown a seat lock block **250** including a seat lock block access port **251**, which operates in association with a seat lock mounting post **265** which has an engagement notch **266**. The seat lock mounting post **265** is received through a tapered opening **267** in the seat lock block **250** so that it can attach thereto. An access block **263** is received within the access port **251**, and a toggle arm **256** is attached between the seat lock block **250** and the access block **263** by means of a toggle arm axle **260**, one end of which is received in the axle mounting hole **252**, the other in an axle mounting hole within the access block **263**. A shoulder **261** on the toggle arm axle **260** is provided. Further, a toggle arm spring **255** provides the necessary force to keep the toggle arm **256** positioned. The mechanism further comprises a hole **254**, extending between the access port **251** and an access opening **268**, and allows the toggle arm **256** to engage the notch **266** in the seat lock mounting post **265**. The post is attached to the seat and the block is mounted to the frame structure. The post/seat is lowered into the hole in the block and the spring loaded arm lever is pushed out of the way until the post lowers significantly allowing the lever to reengage the notch in the post thus locking the post/seat in place. The lever is disengaged via a cable actuated by a lever.

When the seat mounting post is downwardly inserted into the seat lock block opening, a plurality of seat mounting blocks are securely attached to the seat support structure. A plurality of seat lock mounting posts are secure **265** are securely attached to the seat joint.

Seat Bolster Flap

As mentioned above, a seat bolster flap, as shown in FIGS. **42**, **43**, **44** and others, is provided on each side of the seat to help contain or steady the legs of the user. The seat bolster flap **450** has one end thereof mounted in a groove **453** of a bolster flap base **451**, which is in turn mounted on a base plate **454** attached to the seat or other structure. A pin **456** passes through holes **455** in the base plate **454** and the holes **452** in the bottom flap base **451** so that these two components are connected to each other such that they can be selectively pivoted or rotated with respect to each other in order to move the seat bolster flap **450** between an upright position in which it contains the legs, and a retracted position to permit easy access for the user, and multiple selectable positions therebetween.

Two pairs of rosettes **457** are provided and are also mounted on the pin **456**. One pair is closest to the handle **465** and the other is further away. One half of each pair is mounted on the forward faces of the bolster flap base **451** while the other half of each pair is mounted to the back facing faces of the base plate **454**. The pin **456** runs through the center of all the rosette pieces.

One end of the pin threadedly engages in the hole **452**, while the other is treated threaded engaged with a plug **463**. The plug **463** cooperates with a handle **465** including an alignment slot **466**, and an arm spacer **459** is provided. It will be seen that the hole **467** in the handle **465** is not centered, but is in fact slightly off center. Therefore, as the handle **465** is rotated about the hole **467**, it will have the effect of pulling or pushing the pin **456** respectively, causing engagement or disengagement respectively between the rosettes surfaces. When loosened and somewhat disengaged, the seat bolster flap **450** can be more easily pivoted and rotated out of the way. When the user, on the other hand, has placed the seat bolster flap **450** in the desired position, the handle **465** can be rotated to act on the pen **456**, engage the various rosette surfaces, and prevent further rotation or pivoting of the seat bolster flap **450**, until a handle is once more adjusted according to the needs and desires of the wheelchair user.

The invention is not limited to the precise details relating to structure and operation as described above. Many different embodiments for within the scope of the invention.

Throughout this description, the embodiments and examples shown should be considered as exemplars, rather than limitations on the apparatus and procedures disclosed or claimed. Although many of the examples presented herein involve specific combinations of method acts or system elements, it should be understood that those acts and those elements may be combined in other ways to accomplish the

same objectives. Acts, elements and features discussed only in connection with one embodiment are not intended to be excluded from a similar role in other embodiments.

As used herein, "plurality" means two or more. As used herein, a "set" of items may include one or more of such items. As used herein, whether in the written description or the claims, the terms "comprising", "including", "carrying", "having", "containing", "involving", and the like are to be understood to be open-ended, i.e., to mean including but not limited to. Only the transitional phrases "consisting of" and "consisting essentially of", respectively, are closed or semi-closed transitional phrases with respect to claims. Use of ordinal terms such as "first", "second", "third", etc., in the claims to modify a claim element does not by itself connote any priority, precedence, or order of one claim element over another or the temporal order in which acts of a method are performed, but are used merely as labels to distinguish one claim element having a certain name from another element having a same name (but for use of the ordinal term) to distinguish the claim elements. As used herein, "and/or" means that the listed items are alternatives, but the alternatives also include any combination of the listed items.

The invention claimed is:

1. A wheelchair comprising:

a chassis;

a seat mounted on the chassis;

a front wheel assembly mounted on the chassis;

a pair of rear wheels mounted on the chassis; and

a drive train assembly for propelling the wheelchair in a selectively forward or reverse direction, the drive train assembly comprising an arm lever which can be moved back and forth by the user, a drive member connected to the arm lever by means of a chain, and a rear wheel hub assembly connected to the drive member by means of a chain, the rear wheel hub assembly comprising a forward ramp ring and reverse ramp ring, and a pair of inner clutches for selective operative engagement with either the forward ramp ring or the reverse ramp ring.

2. A wheelchair as claimed in claim **1** wherein the chassis is generally constructed of a plurality of block pieces connected to each other by a plurality of tubes.

3. A wheelchair as claimed in claim **1** wherein the seat comprises a base, a seating surface, and a back member, the back member being pivotable relative to the base so as to facilitate folding and storage thereof.

4. A wheelchair as claimed in claim **3** wherein the back member comprises a pair of adjustable pads whose position and orientation can be adjusted to suit the physical requirements of the user.

5. A wheelchair as claimed in claim **3** further comprising a circular lock slot positioned between the base and the back, the lock slot being adjustable between the folded and unfolded position, and a lock stop operation member at the top of the back member.

6. A wheelchair as claimed in claim **3** further comprising a pair of bolsters for supporting the legs of the user, each bolster comprising a plate structure movable between a first selected and variable position for supporting the legs of the user and a second position in which each bolster is moved to a non-operational position.

7. A wheelchair as claimed in claim **1** wherein the front wheel assembly is pivotable relative to the chassis so that it is movable between a folded position for storage and transportation and an unfolded position for use of the wheelchair.

8. A wheelchair as claimed in claim **7** wherein the front wheel assembly comprises a frame member, a foot support, a pair of castor modules, and wheels attachable to the castor modules.

9. A wheelchair as claimed in claim **8** wherein each of the front wheels comprises a pair of wheels.

10. A wheelchair as claimed in claim **1** further comprising an inner clutch slider upon which the inner clutch is mounted, the inner clutch slider having a slot therein for receiving a shift pull post, the shift pull post being axially movable by operation of a cable to shift the inner clutch slider within the rear wheel hub.

11. A wheelchair as claimed in claim **10** wherein the cable extends between the shift pull post and the arm lever such that maneuvering the arm lever would result in varying the tension in the cable to move the inner clutch slider and the inner clutch so as to selectively rotate each of the rear wheels in either a forward or rearward direction.

12. A wheelchair as claimed in claim **11** wherein the rear wheel hub has associated therewith a sprocket which is connected by means of a chain to the drive member.

13. A wheelchair as claimed in claim **12** wherein the drive member has a first sprocket and a second sprocket which connects by means of a chain to the sprocket on the arm lever, and a second sprocket which connects to the sprocket on the wheel hub by means of a chain.

14. A wheelchair as claimed in claim **1** wherein the drive member comprises a torsion mechanism having a torsion housing, a pair of sprockets at each end of the torsion housing, the torsion housing being rotatably mounted on a torsion shaft, the pair of sprockets at each end of the torsion housing being respectively connected to the arm lever and the rear hub respectively.

15. A wheelchair as claimed in claim **14** wherein the torsion mechanism permits up and down movement of the rear wheels thereby imparting a suspension capability for the rear wheels.

16. A wheelchair as claimed in claim **1** wherein each of the rear wheels comprises a pair of wheel plates, the wheel plates being connected to the drive train assembly via the rear wheel hub assembly to form the center and bolted to each other at the outer edges, and a tire mounted over the outer edges.

17. A wheelchair as claimed in claim **16** wherein the wheel plates are substantially flat disk shaped structures which are spaced at an inner portion thereof at the connection to the drive train assembly and taper towards each other and connected at their outer edges.

18. A wheelchair as claimed in claim **1** further comprising a braking mechanism.

19. A wheelchair as claimed in claim **18** wherein the braking mechanism comprises a disk connected to the rear wheel hub assembly and a caliper containing brake pads for selectively engaging the disk, the brake pads being operated by a brake engagement lever.

20. A wheelchair as claimed in claim **1** wherein the seat comprises a base, a seating surface and a back member, the seating surface being ergonomically configured for the comfort of the user.

21. A wheelchair as claimed in claim **1** wherein the arm lever has a lower portion connected to the chassis, a sprocket at or near the lower portion, and an upper portion which extends above the level of the seat so as to be conveniently located for gripping by the user.

22. A wheelchair as claimed in claim **21** wherein the arm lever further comprises an inwardly directed handle at its end remote from the sprocket, and a cable extending within the arm lever from the handle to the hub assembly.

23. A wheelchair as claimed in claim 22 wherein the handles comprise rotatable gear changers, rotation of which acts on the cables to change gears formed in the wheel hub assembly.

24. A wheelchair as claimed in claim 21 wherein the upper portion of the arm lever is selectively rotatable by the user.

25. A wheelchair as claimed in claim 1 wherein the drive member comprises a torsion mechanism.

26. A wheelchair as claimed in claim 1 wherein the rear wheel hub further comprises a neutral position in which neither the forward ramp ring nor the reverse ramp ring is engaged.

27. A wheelchair as claimed in claim 1 further comprising a rotatable handle attached to the arm lever, the rotatable handle comprising a pivot joint block, an internal slider received within the joint block and having at least one lock groove, and an internal fixed locator having at least one engagement tab which releasably engages within the lock groove of the internal slider, the internal slider being axially movable between a first position wherein the tab is engaged within the lock groove and a second position wherein the tab is disengaged from the lock groove and wherein the handle can be rotated relative to the arm lever in the second position.

28. A wheelchair as claimed in claim 27 further comprising a spring operating between a spring floor on the joint block and a shoulder stop on the internal slider for moving the internal slider into the first position when the tab and lock groove are aligned.

29. A wheelchair comprising:

a chassis;

a seat mounted on the chassis;

a front wheel assembly mounted on the chassis;

a pair of rear wheels mounted on the chassis; and

a drive train assembly including a forward drive gear and a reverse drive gear for propelling the wheelchair in a selectively forward or reverse direction, the drive train assembly further comprising an arm lever which can be moved back and forth by the user, a drive member connected to the arm lever by means of a first chain, and a rear wheel hub assembly connected to the drive member by means of a second chain.

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